Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

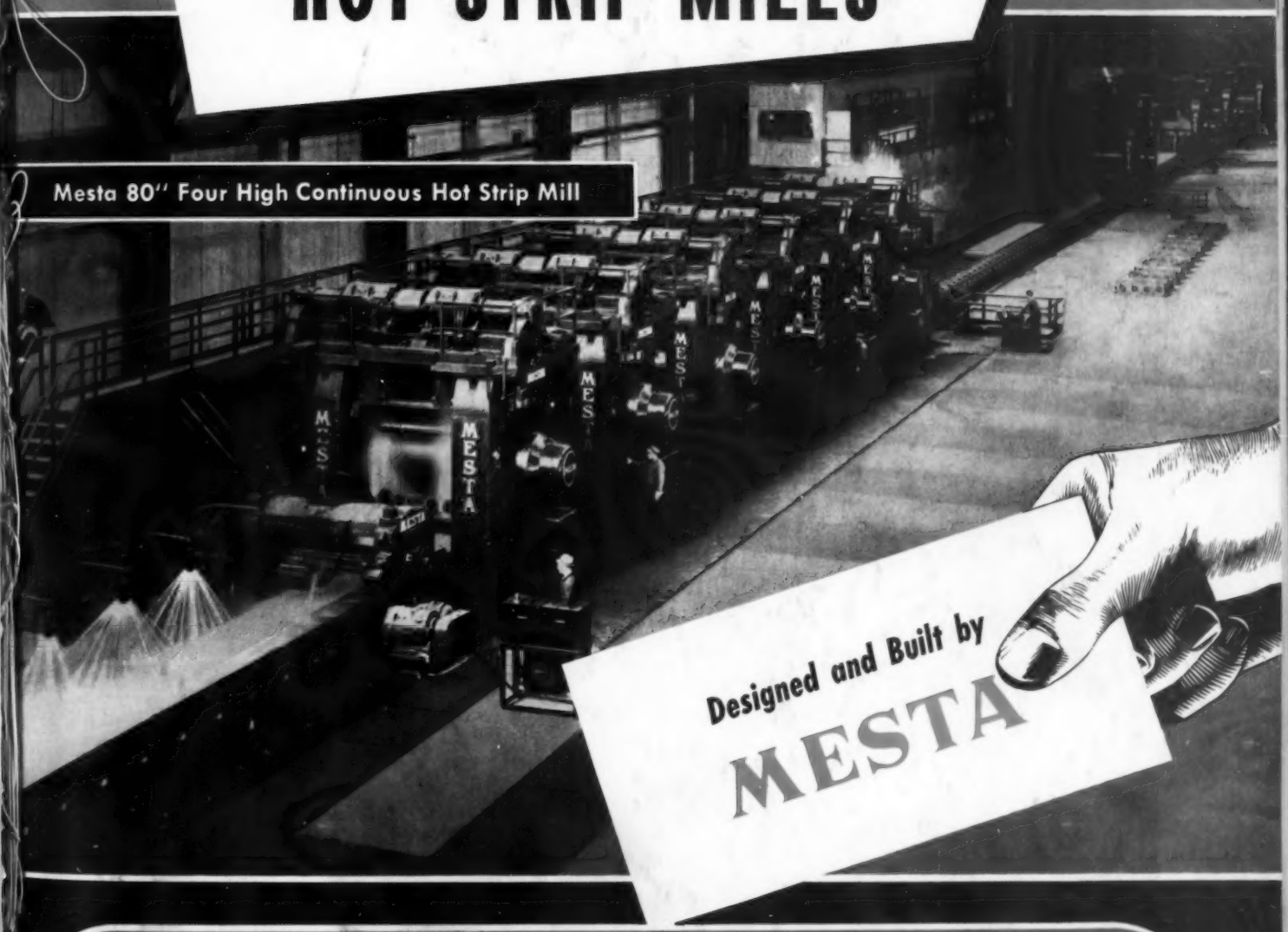
APRIL, 1948

TABLE OF CONTENTS, Page 39

DETROIT

NOLOGY DEPARTMENT

Continuous HOT STRIP MILLS



Mesta 80" Four High Continuous Hot Strip Mill

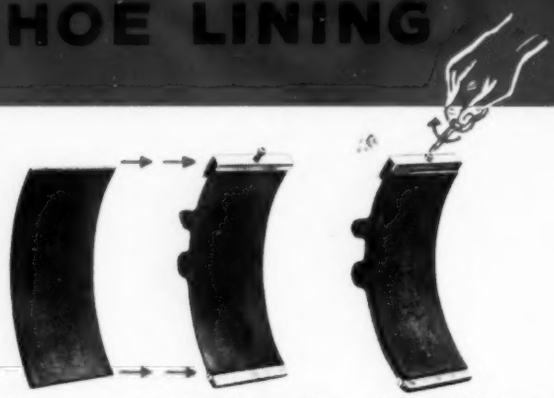
Designed and Built by

MESTA

DESIGNERS AND BUILDERS OF COMPLETE STEEL PLANTS

MESTA MACHINE COMPANY · PITTSBURGH, PA.

Now... An Important New
RIVETLESS CLAMP-ON TYPE
MILL BRAKE SHOE LINING



New lining. No rivets, 100% braking area.

New shoe. Buttress at bottom, simple self-aligning screw jack at top.

Lining fixed, in permanent non-shifting position by action of screw jack.

Renewed in a Jiffy... on the Job!

One of the most important recent advances in steel mill brake practice is this *new* rivetless, clamp-on type of mill brake shoe lining—another result of Cutler-Hammer pioneering. Using the same folded, compressed metallic asbestos as before, this new type of lining has been a revelation in simplicity and ease of lining renewal. In addition to the new clamping design—the elimination of rivet holes helps in the wearing qualities of the lining.

The shoe that holds this lining has a permanent buttress at the bottom and a simple self-aligning screw jack at the top. To renew the lining on the job, you simply loosen the clamp screw, slide out the old worn lining, slide in the new and readjust the brake. The stocking of spare shoe and lining assemblies is no longer necessary. The old method of renewal by riveting new linings in place is eliminated.

Complete details of C-H Type M magnetic brakes with clamp-on linings, and replacement shoes for C-H Type M brakes now in service, will be sent at your request. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ont.

HOW RIVETLESS CLAMP-ON LINING IS *RENEWED ON THE JOB*

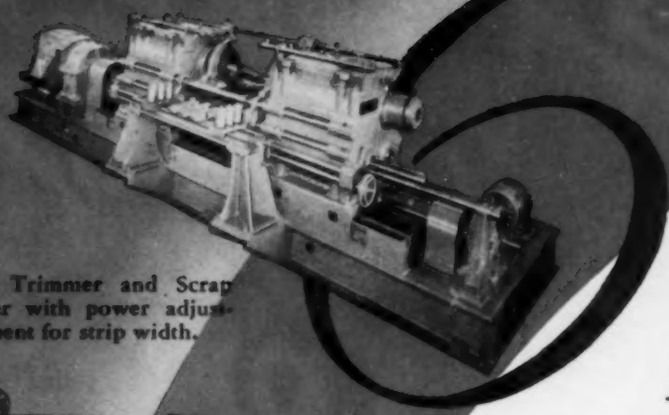
1. Loosen jack screw.
2. Pull out old lining, slip in new.

PROVEN PERFORMANCE

Exhaustive "in-the-field" tests prove this new C-H design will meet the most exacting and severe service.

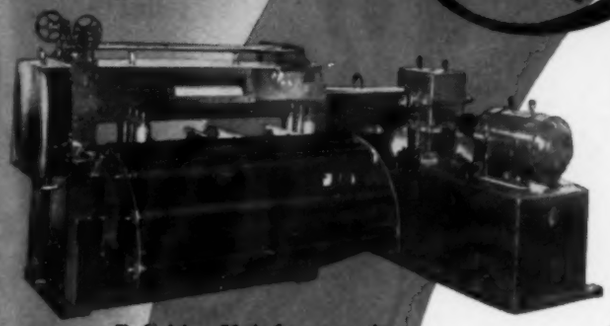
CUTLER-HAMMER
MOTOR CONTROL
C-H

IRON AND STEEL ENGINEER, published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania, under Act of Congress March 3, 1879. $7.50 per year in United States, $8.25 Canada, $10.00 foreign countries. Volume 25, No. 4.

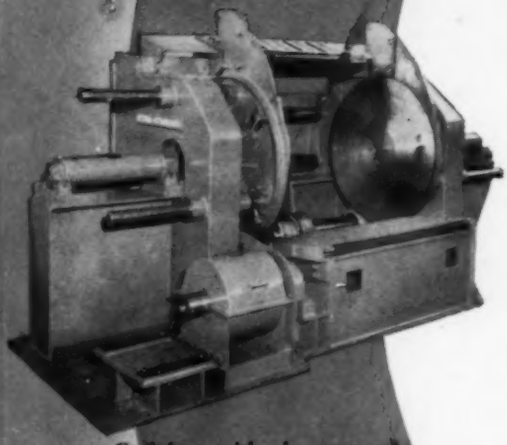


Side Trimmer and Scrap Cutter with power adjustment for strip width.

good items
in Equipment for Flat-Rolled Products



Polishing Unit for a continuous terne line with motor driven buffing wheels.



Coil box with air operated rotating disc side guides, and driven cradle rolls.

The industry has entered a new era in two long-sought processes . . . *continuous application of terne metal and zinc.*

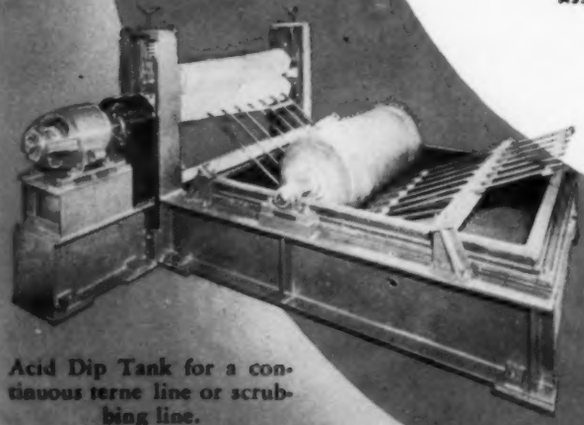
On *all* continuous hot-dipped lines operating now, Aetna-Standard has made major contributions in engineering and developments. If you are considering these new developments, draw upon our experience.

Remember, too, Aetna-Standard ranks first in conventional equipment. See us for levellers, coilers, scrubbing and drying lines, side trimmers, shearing units, coil boxes, scale breakers, or other equipment.

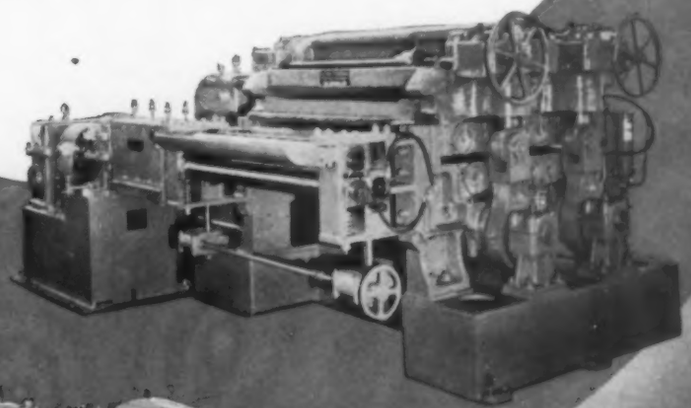
On your requirements, you may want the suggestions of our flat-rolled specialists.

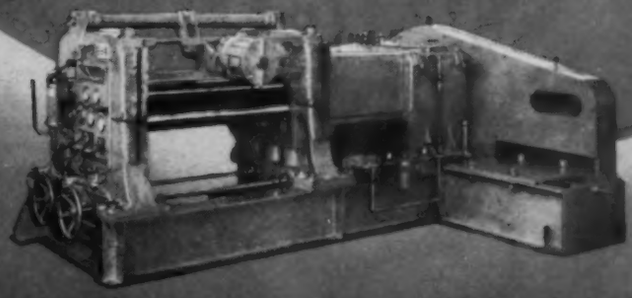
They are at your service.

THE AETNA-STANDARD ENGINEERING COMPANY
YOUNGSTOWN, OHIO
ASSOCIATED COMPANY: HEAD WRIGHTSON & COMPANY, LTD., MIDDLESBROUGH, ENGLAND



Acid Dip Tank for a continuous terne line or scrubbing line.





Pull-through Leveller or Scale Breaker with uncoiling feed-in unit.

5½" Roller Leveller or Uncoiler for various continuous processing lines.

It takes a lot of

EXPERIENCE

The lady target has lots of confidence in her knife-throwing partner because she knows he's had years of experience at his trade.

The roll buyer, too, is in the lady's position—he must know that the roll maker has lots of experience at *his* trade.

Here, at National, we've been making and supplying rolls since 1909 to leading fabricators in all types of industries *to their satisfaction*. We know we can supply your roll requirements to *your satisfaction*. Just try us and see.

NATIONAL ROLLS

National Rolls

THE NATIONAL ROLL & FOUNDRY CO.

AVONMORE, PENNSYLVANIA

SPECIALISTS IN IRON AND ALLOY IRON ROLLS

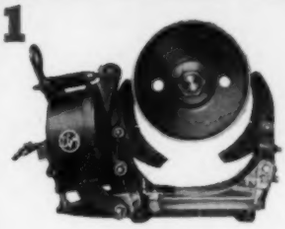
When Buying Electric Cranes

LET EC&M SUPPLY FULL COVERAGE

BRAKES · DISCONNECT SWITCHES
CONTROLLERS · LIMIT STOPS

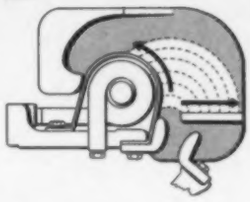
EC&M's Complete Line Includes—

1



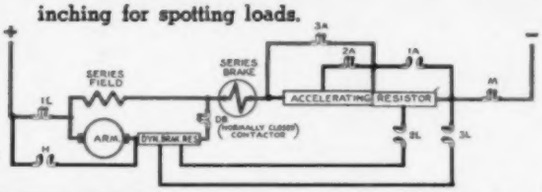
LONG-LIFE brakes for cranes operated by a-c or d-c power. . . Give high speed performance—with low upkeep.

2

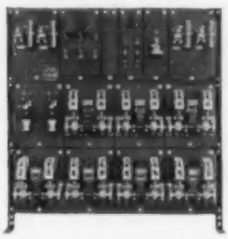


Contactors operate on the LINE-ARC principle — no destructive burning of arc shields—cool contacts . . . reduced maintenance.

3 Simplified, Safe Dynamic Lowering Circuits for hoist motions respond quickly and permit accurate inching for spotting loads.



4



Reversing-plugging Control for bridge and trolley motions — automatically-controlled acceleration and only one adjustable relay for plugging.

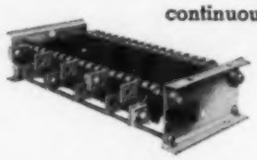
5

Youngstown Safety Limit Stops protect against overhoisting accidents—a positive check against human errors.

6

Cam-type Master Switches have narrow width and short throw—less fatiguing on the operator.

7 Tab-Weld Plate Resistors—spot-welding provides a continuous path, and keeps resistance value constant.



8

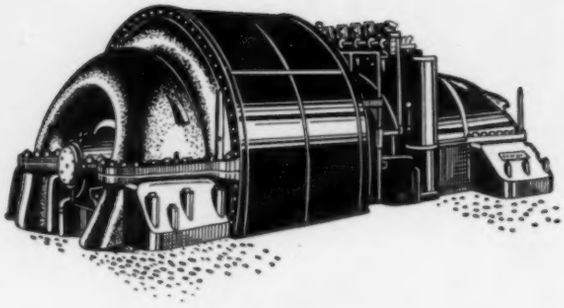
Manual-magnetic Disconnect Switches operate with ease—are arranged to control crane lights, too.

Put your crane control problems up to EC&M. Each job is accurately engineered to give fine performance. When buying cranes, specify EC&M for complete crane control.

EC&M's Fiftieth Anniversary

THE ELECTRIC CONTROLLER & MANUFACTURING CO.

Filtered Air solves blade erosion problem on Turbo-Blowers



WHY should the life expectancy of impellers in turbo-blowers be limited to six, nine or eighteen months? The reason—when quantities of abrasive dust and dirt, such as found in unfiltered air, are permitted to enter a high speed, rotary blower, rapid wear and erosion of the impeller is certain to result.

Installation of AAF Multi-Duty Air Filters at the blower intake has proven a practical solution to this problem. In one mill, where unfiltered air had completely ruined the impeller after 17,000 hours' operation, the replacement unit checked after 12,000 hours with Multi-Duty filtered air showed no trace of erosion.

The AAF Multi-Duty is an automatic self-cleaning air filter. Overlapping panel construction of the filter curtain combines positive self-cleaning and high efficiency air cleaning as integral functions of the operating cycle. Uniformly constant air supply is assured as operating resistance remains fixed when once established for a given dust concentration.

The Multi-Duty's record of prolonging impeller life, eliminating costly repairs and untimely shutdowns warrants your immediate investigation. For complete information contact your local AAF representative or write direct to:

AMERICAN AIR FILTER COMPANY, INC.
302 Central Avenue, Louisville 8, Ky.
In Canada: Darling Bros., Ltd., Montreal, P. Q.

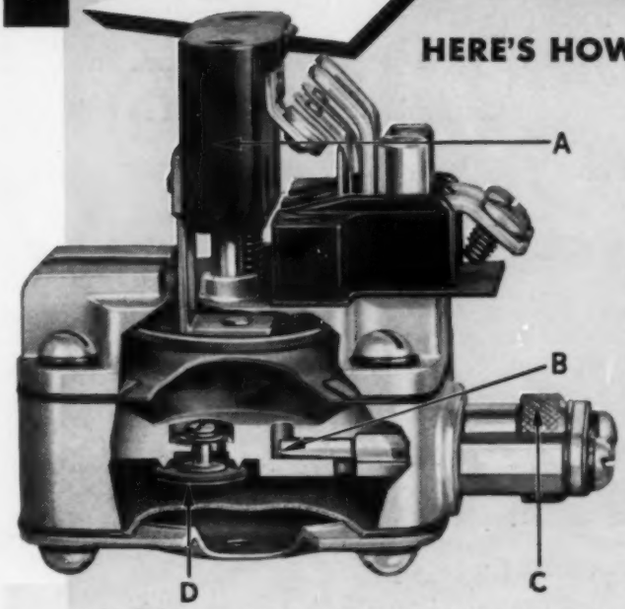
®AAF

AIR FILTERS
AND DUST CONTROL EQUIPMENT

PNEUMATIC TIMERS Do It Better

ACCELERATE MILL MOTORS . . . *and* CONTROL AUTOMATIC PROCESSES

HERE'S HOW THEY WORK



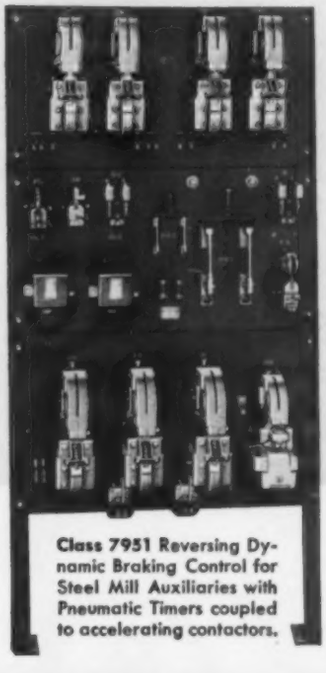
Timing head can be coupled to a contactor or actuated by separate magnet. Contact member (A) is normally pushed down against compression spring. When contact member is released, a rubber diaphragm is flexed upward, drawing air from lower chamber to upper chamber through metering orifice (B). Rotation of knurled wheel (C) advances or withdraws pin to give wide range adjustment. Air returns through valve (D) for instantaneous reset. Lower diaphragm is double layer felt.

Square D's PNEUMATIC TIMERS, a product of over 10 years' experience in many difficult fields of application, offer these proven design and performance features.

- **Extremely accurate**
- **Adjustable over wide range**
- **Unaffected by dust or usual fluctuations in voltage or temperature**
- **Dependable over long periods of severe service**
- **Simple, flexible and easily applied**
- **Attached to contactors or actuated by separate magnet**

• Accurate, fixed timing insures uniform motor acceleration under all conditions of application. Operators are able to obtain closer control by anticipating machine response. Unusually wide range adjustment permits choice of timing period to cover any acceleration requirement.

Processing of steel and associated materials consists of many individual operations performed in timed sequence. (For example—the interval allowed for dumping a blast furnace skip bucket before the hopper rotates.) Pneumatic timers are available for time-delay making or time-delay breaking of a circuit after either energization or de-energization of contactor or separate magnet. Their use in an automatic control circuit simplifies equipment and provides the accuracy and reliability essential to efficient performance.



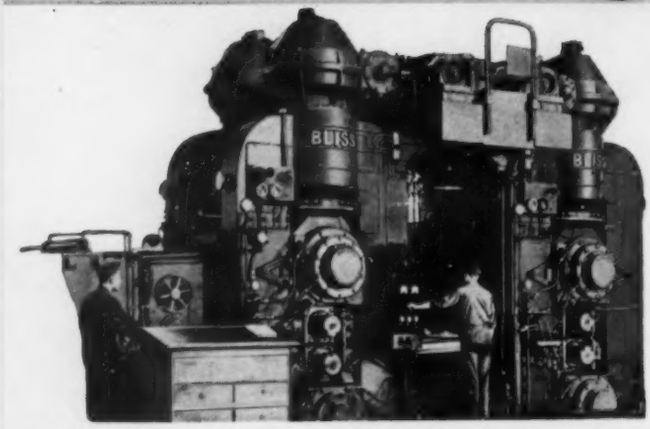
Class 7951 Reversing Dynamic Braking Control for Steel Mill Auxiliaries with Pneumatic Timers coupled to accelerating contactors.

***Write** for HEAVY DUTY DC MILL CONTROL CATALOG which includes complete information on the Pneumatic Timer and its uses: Square D Company, 4041 North Richards Street, Milwaukee 12, Wis.*

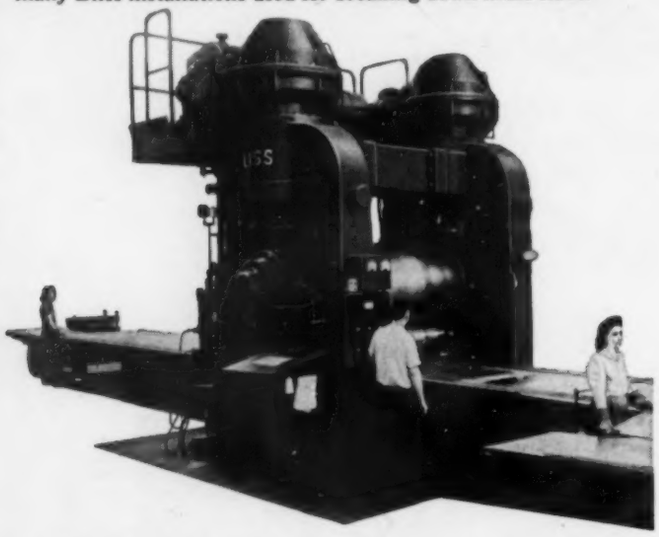
SQUARE D COMPANY

DETROIT • MILWAUKEE • LOS ANGELES

In Rolling Mills, too,



BRASS—16" x 34" x 34" two stand tandem four-high mill is one of many Bliss installations used for breaking down brass slabs.

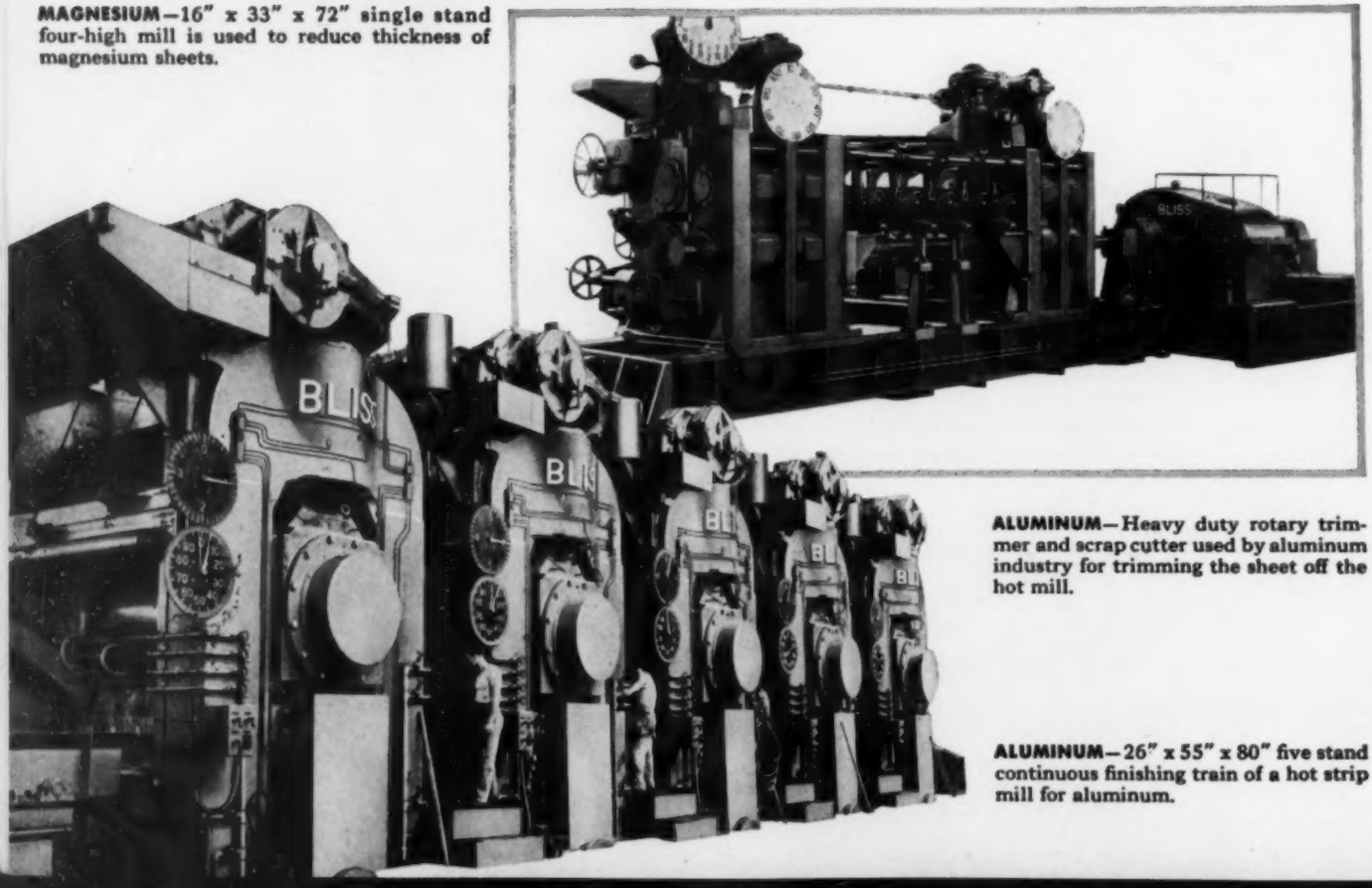


MAGNESIUM—16" x 33" x 72" single stand four-high mill is used to reduce thickness of magnesium sheets.

Hundreds of outstanding Bliss sheet and strip mill installations—here and abroad—give daily evidence of the close cooperation between customer and builder which alone can create a mill exactly suited to the job at hand.

Whether your requirements concern 2-, 3-, 4-high or cluster mills; hot or cold-rolling of ferrous or non-ferrous metals, Bliss can supply the equipment especially designed to suit *your* needs. Bliss also builds an extensive variety of accessories: mandrel type hot mill coilers, up-coilers, slitters, etc. Some of this equipment are illustrated on these pages.

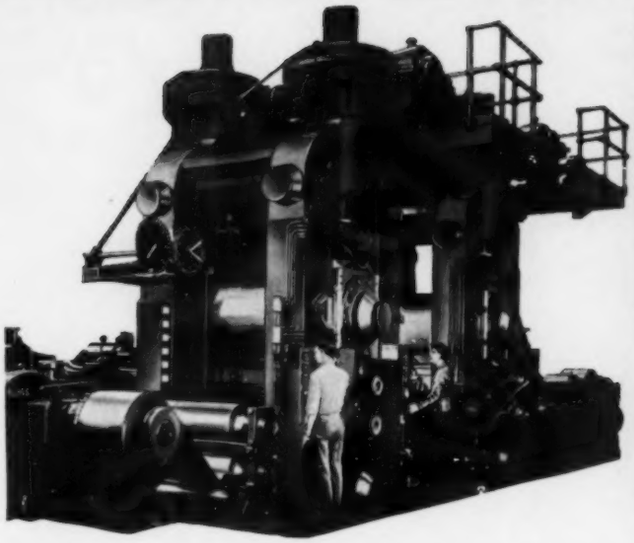
Put your rolling mill problem up to Bliss. You'll find the same keen engineering counsel and service which have made Bliss the first name in presses for more than 90 years.



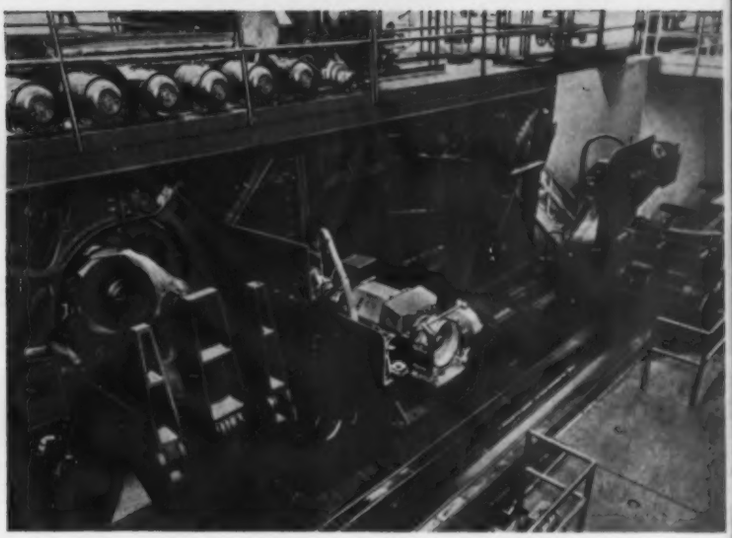
ALUMINUM—Heavy duty rotary trimmer and scrap cutter used by aluminum industry for trimming the sheet off the hot mill.

ALUMINUM—26" x 55" x 80" five stand continuous finishing train of a hot strip mill for aluminum.

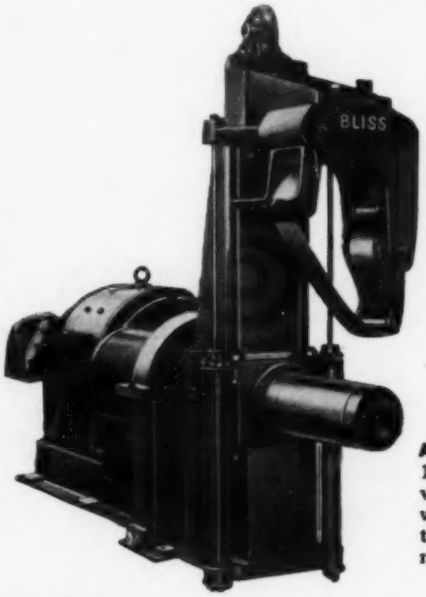
Stay Ahead with Bliss



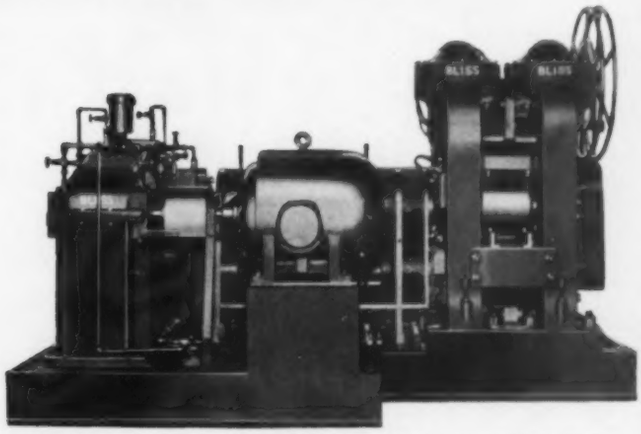
TIN PLATE—18" x 42½" x 42" two stand tandem temper pass mill for tin plate.



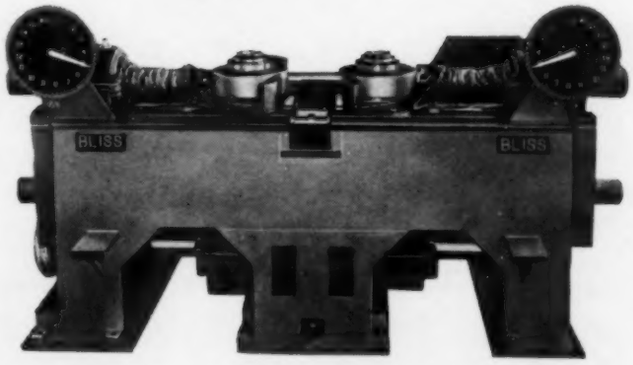
STEEL—Improved type hot strip downcoiler and upender for a Bliss 48" continuous strip mill.



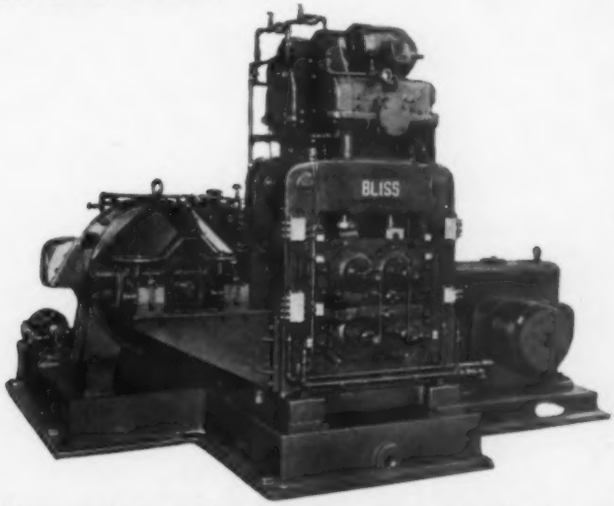
ACCESSORY—12" x 18" tension reel with vertical type belt wrapper has application in ferrous and non-ferrous fields.



COIN METAL—14" x 12" two-high mill used in government mints—typical of smaller Bliss mills.



ACCESSORY—20" Vertical edger for edging 8" to 40" wide slabs.



THIN GAGE METALS—3¼" x 9" x 8" Cluster Mill for cold reducing high carbon alloy and stainless steels from gages of .125" to .004".

E. W. BLISS COMPANY

450 AMSTERDAM AVENUE, DETROIT 2, MICHIGAN

STAY AHEAD WITH *Bliss*

Rolling Mills...Mechanical and Hydraulic Presses...Container Machinery

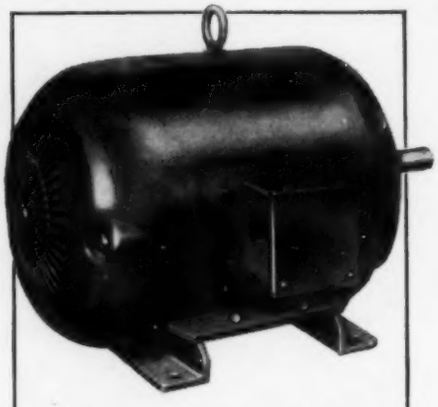
There's DIRTY WORK in STEEL MILLS

...but it doesn't bother Wagner *type CP* Motors

Wagner Totally-Enclosed, Fan-Cooled Motors (Type CP) are built to "take it" . . . They are completely *sealed* against harm from dust, dirt, steel chips, abrasives, acid fumes, or other destructive matter that would quickly ruin an ordinary motor. That's why steel mills, and other industrial plants throughout the world have thousands of these Wagner Protected Motors on the job, giving dependable service —doing big jobs—dirty jobs —without asking favors.

You, too, can rely on Wagner Quality Motors for continuous, troublefree performance in your plant. Investigate Wagner—the complete line . . . built by engineers who *know* how to build motors that meet your requirements. Nationwide service facilities are available to users of Wagner Motors.

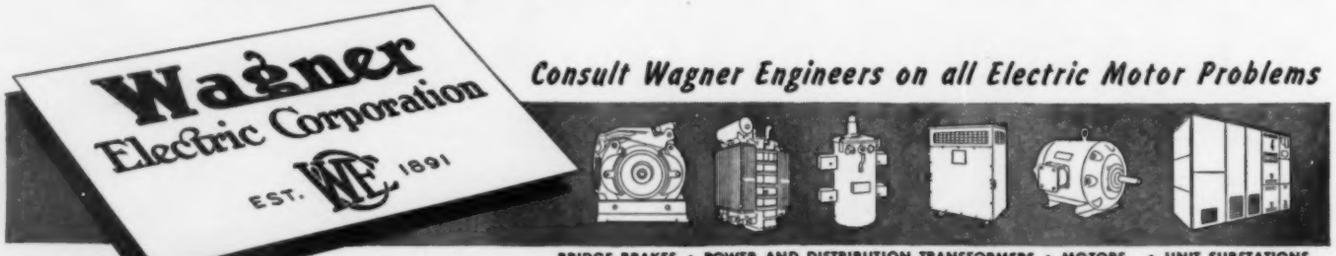
Call any of our twenty-nine branch offices, located in principal cities and manned by trained field engineers, for advice on all of your motor problems. Bulletins on the complete line of Wagner Motors will be sent upon request.



Pictured above is a Wagner totally-enclosed fan-cooled motor. Wagner makes a complete range of motors for every application.

Wagner Electric Corporation
6483 PLYMOUTH AVE., ST. LOUIS 14, MO., U. S. A.

Consult Wagner Engineers on all Electric Motor Problems



BRIDGE BRAKES • POWER AND DISTRIBUTION TRANSFORMERS • MOTORS • UNIT SUBSTATIONS

M48-7

ELECTRICAL AND AUTOMOTIVE PRODUCTS

NOW!

SOLUBLE OIL THAT PREVENTS

"MONDAY MORNING ODOR"

For high-speed, carbide-tool milling, use *Texaco Soluble Oil* C. Your emulsion will be stable and free from objectionable odors . . . assuring closer tolerances, better finish, longer tool life, less scrap.

Proved in Hundreds of Plants

No need now to put up with the disagreeable odor that commonly develops in soluble oil emulsions, and is particularly noticeable on Monday mornings after weekend shutdowns. *Texaco Soluble Oil* emulsions stay free from objectionable odors.

This Texaco superiority has been proved in hundreds of the country's largest plants . . . in both hard and soft water areas . . . where a switch to *Texaco Soluble Oils* has cleared up this "Monday morning odor" condition.

Furthermore, *Texaco Soluble Oil* emulsions are remarkably stable and odorless. Objectionable odor is a sure sign of emulsion instability . . . likely to result in rusted parts, shortened tool life and dirty machines. *Texaco Soluble Oil* emulsions retain their stability in service . . . promote faster, better cutting . . . prolong tool life . . . assure less scrap.

Eliminate "Monday morning odor" in your plant. A Texaco Lubrication Engineer specializing in cutting oils will gladly show you how. Just call the nearest of the more than 2500 Texaco Distributing Plants in the 48 States, or write:

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

TEXACO CUTTING, SOLUBLE AND GRINDING OILS FOR FASTER MACHINING

TUNE IN . . . TEXACO STAR THEATRE every Wednesday night featuring Gordon MacRae and Evelyn Knight . . . ABC Network

ANNOUNCING A CAPACITY RATINGS

**Makes possible the use of smaller bearings—
with savings in bearing cost, material cost and weight
—and more compact product design**

IN the ten years since the present load capacity ratings of Timken tapered roller bearings were established, Timken bearings have been steadily improved. Improved so much that today the load carrying capacity of Timken bearings is a good *25% greater* than it was 10 years ago!

As a result, The Timken Roller Bearing Company is now able to announce a 25% increase in the load capacity ratings of all Timken bearings —following a careful review of laboratory studies on fatigue life machines over the past ten years, together with close observation of bearing performance in the field.

Permits Use of Smaller Bearings

Now you can safely carry your present bearing loads on smaller size Timken bearings. Reductions in sizes of shafts and housings may be possible. Products can be made more compact—lighter in weight. You have an opportunity to save both on bearing costs and material costs. And this increase in ratings should enable engineers to utilize the advantages of Timken bearings in an even broader variety of applications than has been practicable in the past.

Result of Constant Quality Improvement

This 25% increase in Timken bearing capacity ratings is based on continued improvement in the quality of Timken tapered roller bearings over the past 10 years. It is due to a number of factors, including improved alloy steels made in our own Timken steel mill specifically for anti-friction bearings, better metallurgical control in the processing of this steel, more accurate manufacturing equipment, greatly improved surface finishes, and more accurate inspection methods. That these improvements in Timken bearing quality have resulted in 25% greater load capacity has been conclusively demonstrated by years of exhaustive laboratory and field studies!

New Engineering Journal to Give Facts

A new Timken Engineering Journal is now in

25% INCREASE IN OF TIMKEN® BEARINGS

The result of years of constant improvement in Timken bearing quality—supported by exhaustive laboratory studies and extensive field experience

preparation which will give complete capacity rating tabulations and will also include new bearings introduced since the last publication. Pending publication of the new Journal you may take full advantage of the 25% capacity increase by multiplying the existing ratings by 1.25.

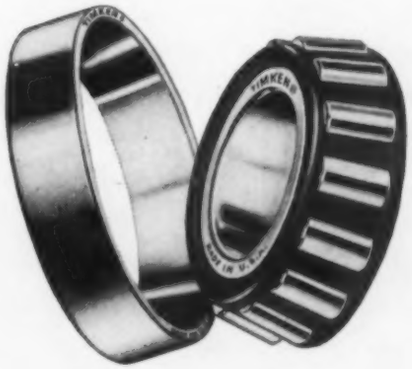
For further assistance in the application of Timken bearings, call upon our field engineers or our Engineering Department.

Timken tapered roller bearings take any combination of radial and thrust loads, hold shafts in rigid alignment, assure precision and minimize friction. The 25% increase in load capacity ratings is the *latest* example of Timken leadership in serving the bearing needs of all industry . . . one more reason why it pays to look for the trade-mark "Timken" on every bearing you use. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ⬮ AND THRUST ⟷ LOADS OR ANY COMBINATION ✳

No sag...no drag...Coils ride safely and gently on LINK-BELT Conveyors

Coils that ride the Link-Belt Conveyor make their trip safely. Ample bearing surfaces and sturdy construction prevent the sag and drag that scuff strip edges. Telescoping is eliminated and the reduction in edge damage has a marked effect on scrap losses; accomplishing a reduction in the cost of tin plate production.

Link-Belt conveyors offer carefree operation. Ruggedly built, smooth running, Link-Belt offers designs for handling coils in various positions, allowing complete flexibility in mechanical handling.

Discuss your plans for mill modernization with a Link-Belt Engineer, the man backed by broad experience in your materials handling problems.

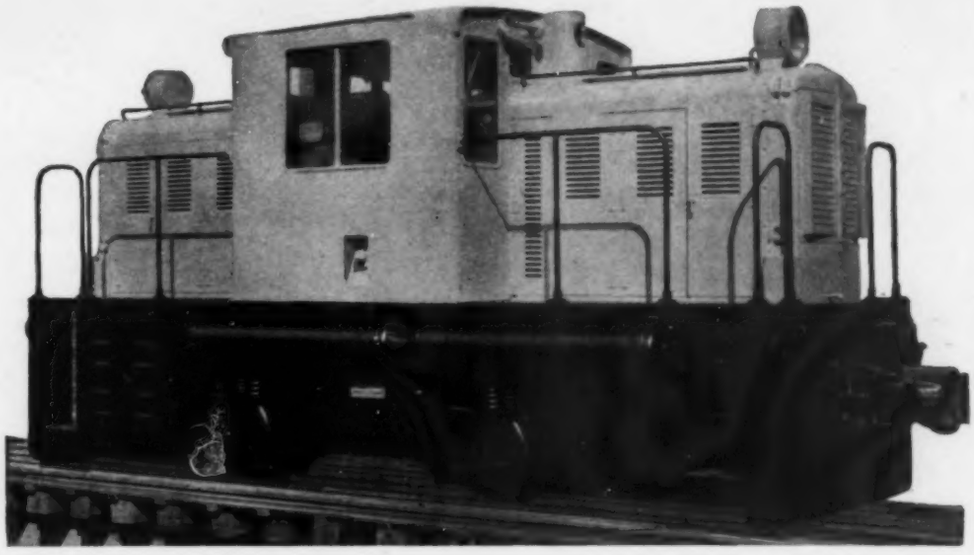
LINK-BELT COMPANY

SERVICE TO STEEL BY LINK-BELT . .

Complete line of Chains for transfer tables, coil conveyors, furnace conveyors, feeder and catcher tables, sheet pilers, draw bench and other equipment . . . Elevators and Conveyors of all types, such as belt, bucket, screw, flight, Bulk-Flo, drag chain, apron, Sidekar-Karrier, trolley, Oscillating-Trough, etc. . . . Vibrating Screens . . . Dryers and Coolers . . . Skip Hoists . . . Car Dumpers . . . Car Spotters and Haulage Systems . . . Portable Conveyors and Bucket Loaders . . . Traveling Water-Intake Screens . . . Automatic Stokers . . . Silent and Roller Chain Drives . . . Speed Reducers and Increasers . . . Variable Speed Transmissions . . . Sprockets . . . Gears . . . Clutches . . . Couplings . . . Babbitted, Ball and Roller Bearings, etc.

10,281

Chicago 9, Pittsburgh 19, Cleveland 13, Detroit 4, Indianapolis 6, St. Louis 1, Kansas City 6, Mo., Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices in Principal Cities.



THE NEWEST THING ON WHEELS FOR STEEL MILL OPERATIONS

Illustrated is the sixth of a series of 50-ton Whitcomb Diesel Electric Locomotives all identical that were recently placed in service at a steel plant.

Designed especially for application in and around steel mills this 50-ton work-horse is equipped with several special features and characteristics that increase its all around efficiency in terms of greater performance and ease of operation — resulting in safer, surer switching and hauling.

Increased visibility for operator is made possible by the new arrangement of windows — more spacious cab is free from drafts as all equipment is enclosed in cabinets — batteries are more accessible for servicing in this new convenient location on the sides — bulk-heads between engines and generators protect the latter from excessive engine heat — safety step-wells provide extra protection for switchmen.

Write for further interesting details regarding this latest locomotive development for steel mills and information explaining how Whitcomb engineers can assist *you* in solving *your* haulage problems.

DIESEL ELECTRICS FROM 25 TO 95 TONS
DIESEL MECHANICALS FROM 3 TO 30 TONS

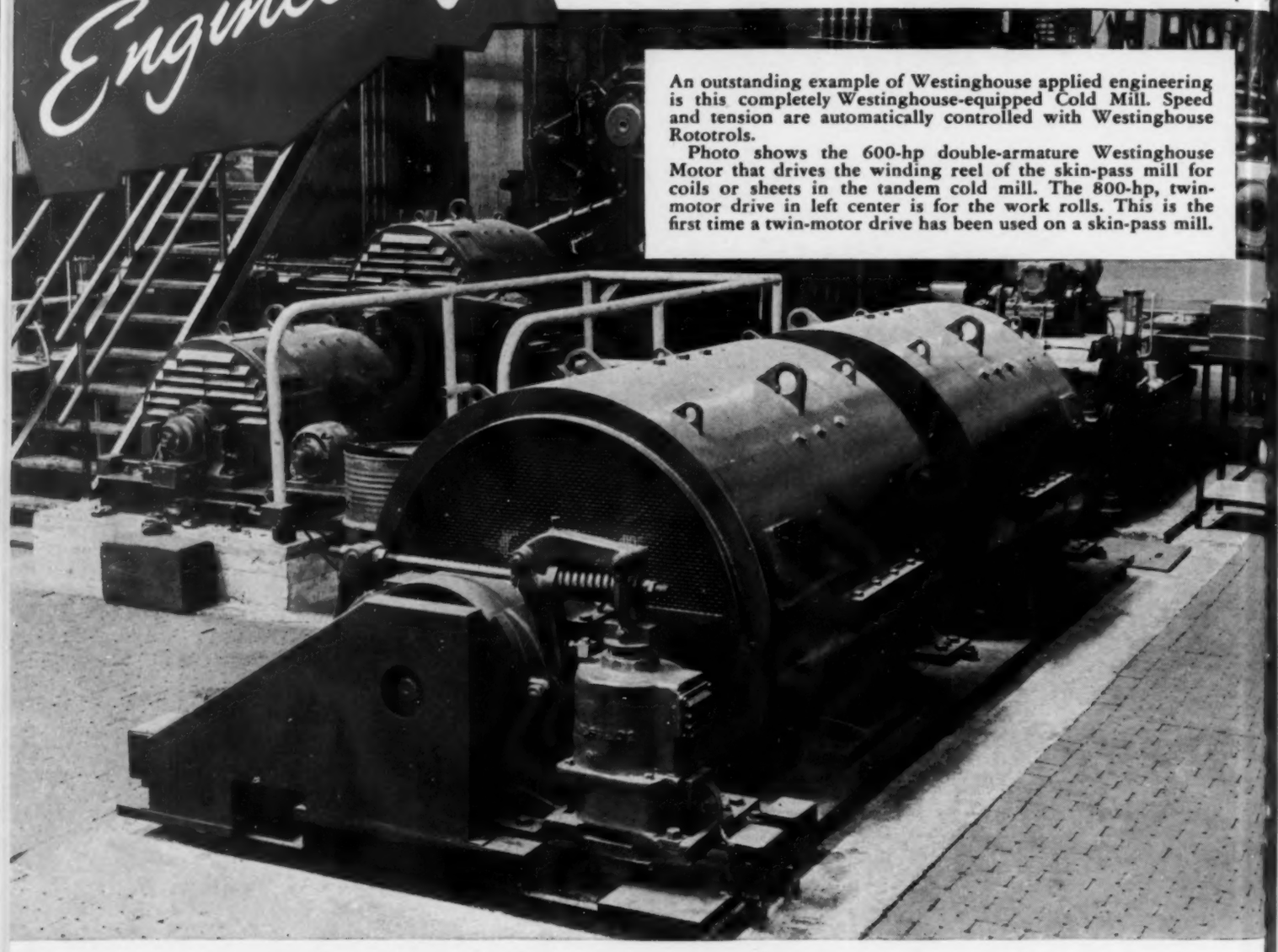
THE BALDWIN GROUP

THE WHITCOMB LOCOMOTIVE CO.

ROCHELLE, ILL.

Subsidiary of THE BALDWIN LOCOMOTIVE WORKS

Applied Engineering TO BRING YOU MORE



An outstanding example of Westinghouse applied engineering is this completely Westinghouse-equipped Cold Mill. Speed and tension are automatically controlled with Westinghouse Rototrols.

Photo shows the 600-hp double-armature Westinghouse Motor that drives the winding reel of the skin-pass mill for coils or sheets in the tandem cold mill. The 800-hp, twin-motor drive in left center is for the work rolls. This is the first time a twin-motor drive has been used on a skin-pass mill.

WESTINGHOUSE CONTRIBUTIONS TO THE STEEL INDUSTRY

Today's mechanized steel mills owe much of their operating efficiency to important Westinghouse developments, worked out in co-operation with steel mill engineers.

Many of these contributions are a matter of record, and include:

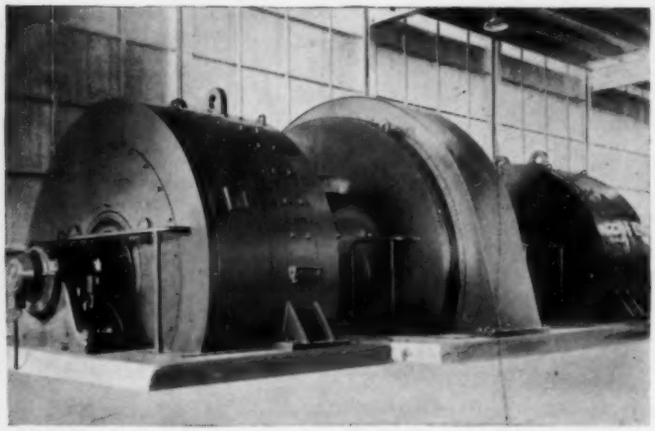
- **the first installation of electric motors in a steel mill in this country**
- **the first large, single-unit, reversing mill main drive motor**
- **the first tensiometer**
- **the first large, twin-motor, reversing mill drive**
- **the fundamental method of controlling electric arc furnaces**
- **the first complete line of arc furnace control**

Let Westinghouse applied engineering work for you . . . in the correct use of electrical apparatus for most efficient plant operation . . . in the development and application of new methods and equipment for your specialized requirements. Complete layout drawing service for mill setups—tailor made to solve your problems—with recommended types and sizes of equipment, is available. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-94770

PRODUCTIVE POWER

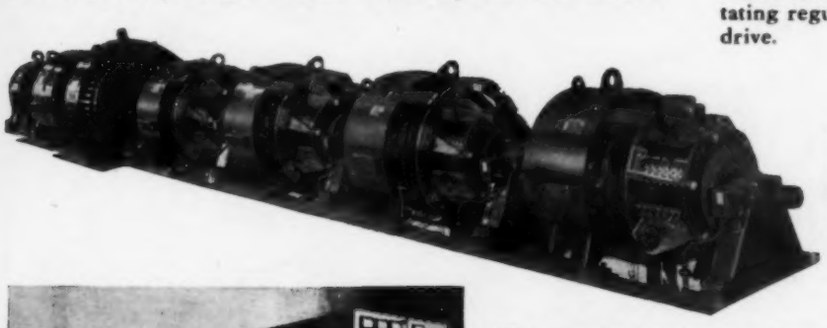
FROM PLANNING BOARD TO PRODUCT, HERE'S HELP IN PRODUCING FASTER, CHEAPER, BETTER ELECTRICALLY

This broad engineering service is an important *plus* to consider when you buy electrical equipment. A complete and separate Westinghouse Steel Industry Department, staffed by competent engineers intimately acquainted with steel and metal-working problems, assures the prompt and practical application of new Westinghouse developments to your special production techniques.



8,000-kw, synchronous m-g set for the tandem mill. The 11,200-hp, 300-rpm, 90% pf Westinghouse Synchronous Motor in the center drives two 4,000-kw, 720-volt, d-c generators. System power factor is automatically controlled by a Rototrol regulator which adjusts the excitation of the synchronous motor.

Main roll drive motors for the tandem mill. In the background is a 2,000-hp, Westinghouse Motor for stand 1, next a 2,500-hp motor for stand 2 and two 3,000-hp, twin-motor drives for stands 3 and 4. In right foreground is a 600-hp, double-armature motor for tension reel, and in left foreground are Rototrol rotating regulators and exciters for mill motors and tension reel drive.



This IR drop compensator assures a constant speed, regardless of load, at any voltage adjustment from threading to running voltage. The four d-c booster generators on the right are driven by the 800-hp, Westinghouse Motor, third from left.

One of seven 750-kva, Westinghouse Power Centers for low-voltage power in the tandem mill. Transformer is Inerteen cooled. Feeder circuits are protected by 1,200-ampere "draw-out" type air circuit breakers.

Three-ton coil being transferred from pickling line conveyor, visible in background. A 100-hp, Westinghouse Mill-type Motor drives the main hoist of this 40-ton crane. Westinghouse control for hoist, bridge and trolley is housed in metal cabinets, two of which appear at left.

Westinghouse

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

MORE PRODUCTIVE POWER FOR INDUSTRY

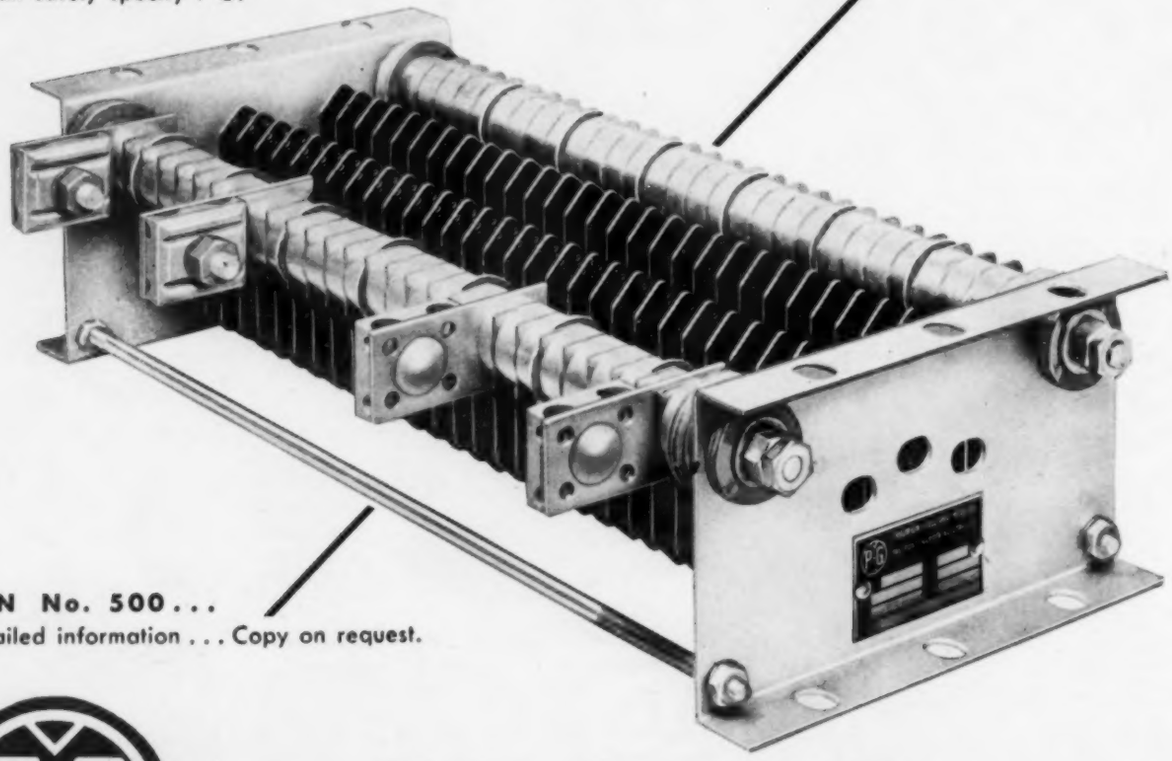
DEPENDABLE Protection *with* P-G *Steel Grid Resistors*

Steel and Mica, with P-G design, create a resistor really able to protect electrical equipment, especially, where service requirements are severe.

P-G Steel Grid Resistors are sturdy, light in weight, and consistently dependable.

These resistors maintain unusually constant resistance values regardless of temperature or age.

Where "trouble-free" resistor service is essential . . . you can safely specify P-G.



BULLETIN No. 500 . . .
Gives detailed information . . . Copy on request.

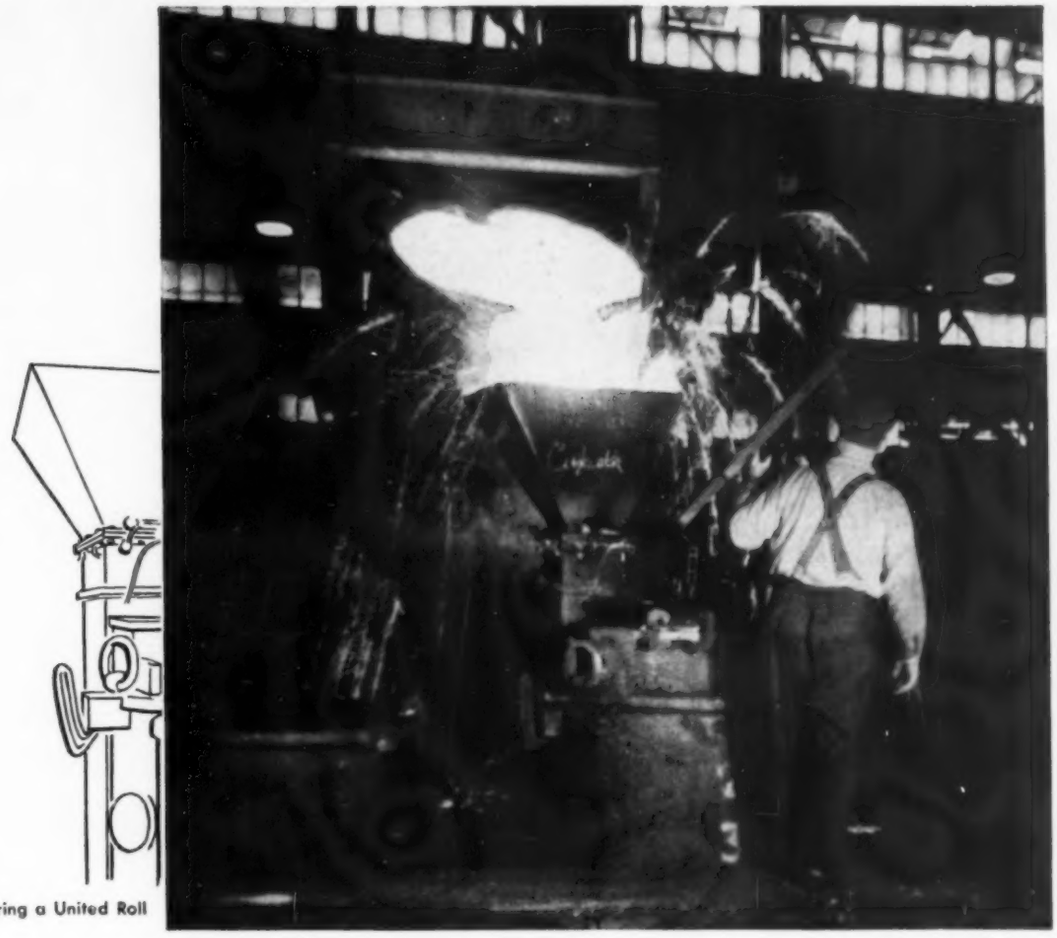
P-G

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO



Pouring a United Roll

UNITED...

ROLLS FOR EVERY TYPE OF MILL

UNITED ENGINEERING AND FOUNDRY COMPANY

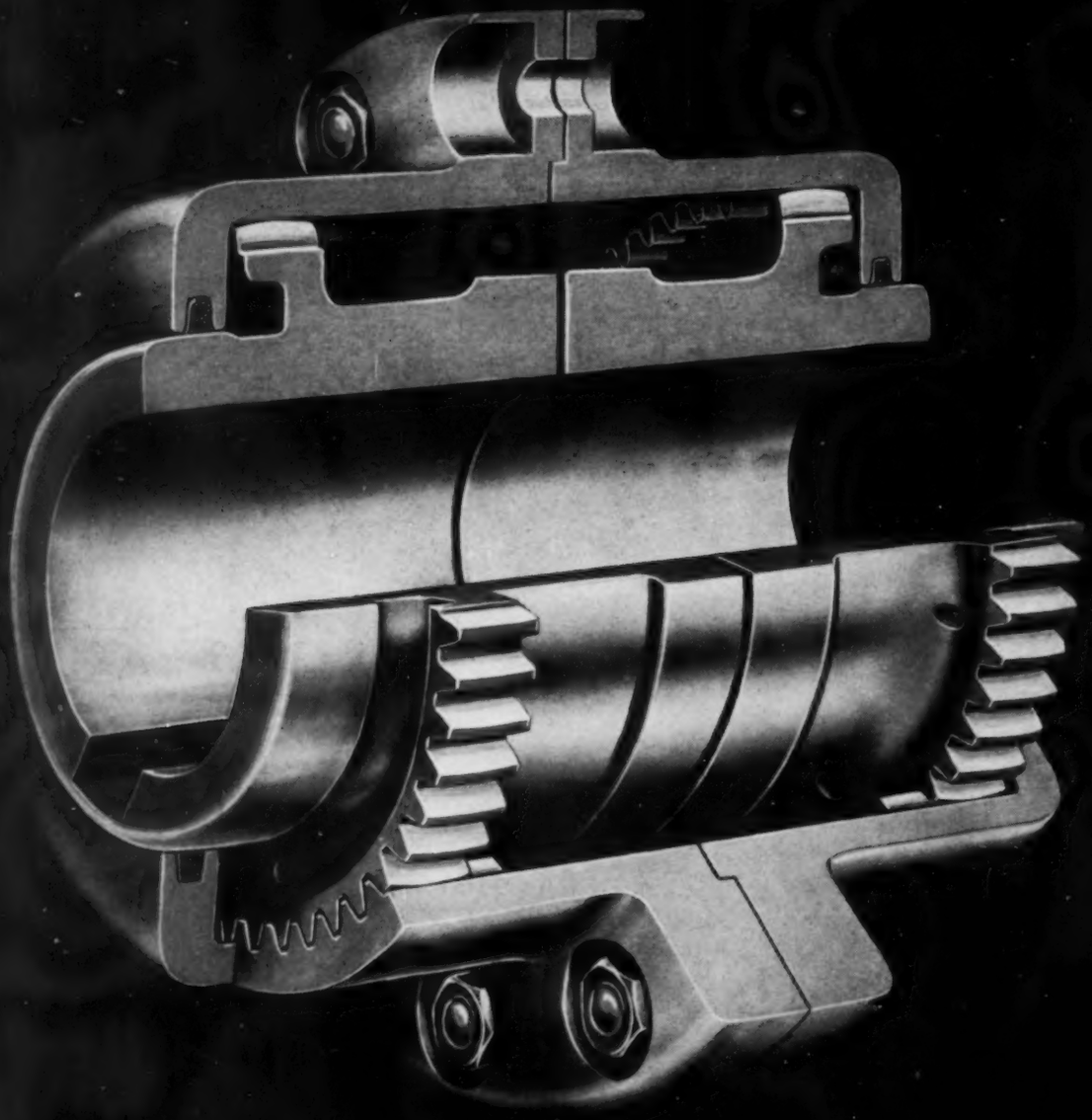
Pittsburgh, Pennsylvania

Plants at Pittsburgh · Vandergrift · New Castle · Youngstown · Canton
Subsidiary: Adamson United Company, Akron, Ohio

Affiliates: Davy and United Engineering Company, Ltd., Sheffield, England
Dominion Engineering Works, Ltd., Montreal, P.Q., Canada
S. E. C. I. M., Paris, France

REG. T. M.

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

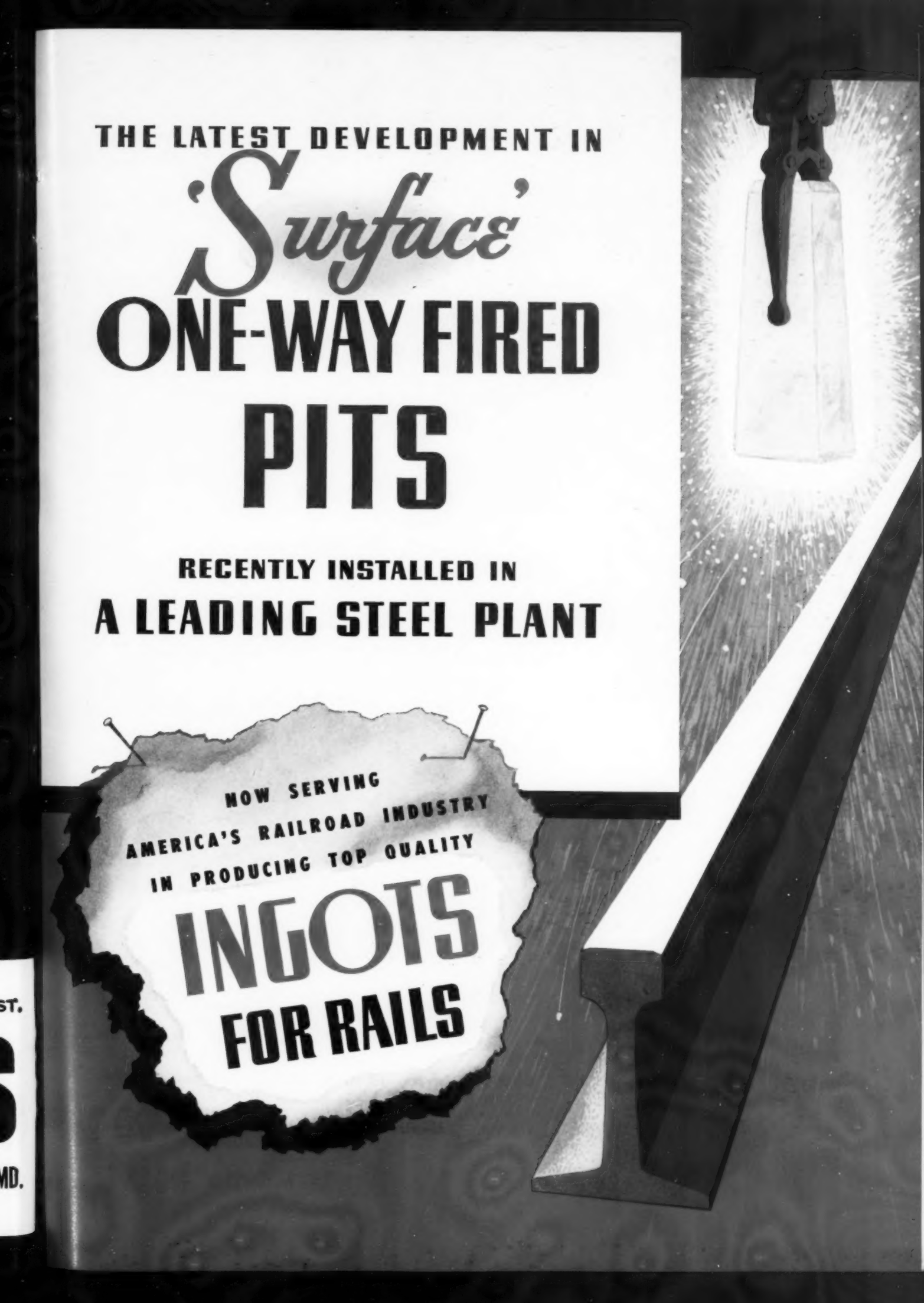
WOODBERRY, BALTIMORE, MD.

THE LATEST DEVELOPMENT IN

'Surface' ONE-WAY FIRED PITS

RECENTLY INSTALLED IN

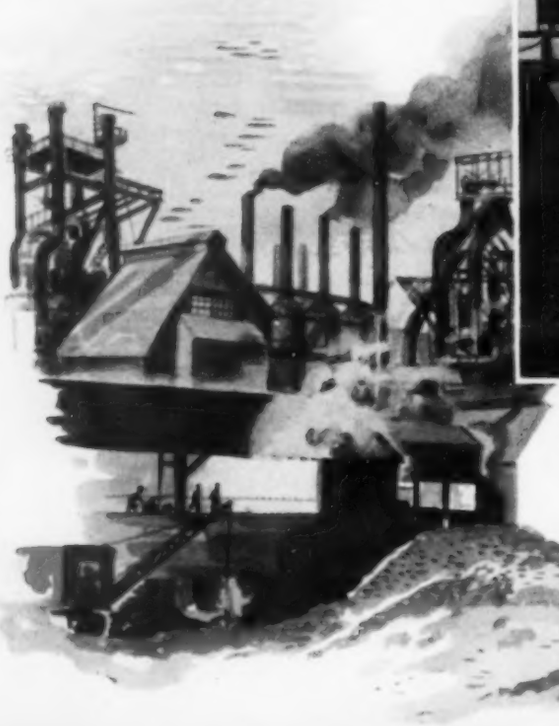
A LEADING STEEL PLANT



NOW SERVING
AMERICA'S RAILROAD INDUSTRY
IN PRODUCING TOP QUALITY

INGOTS FOR RAILS

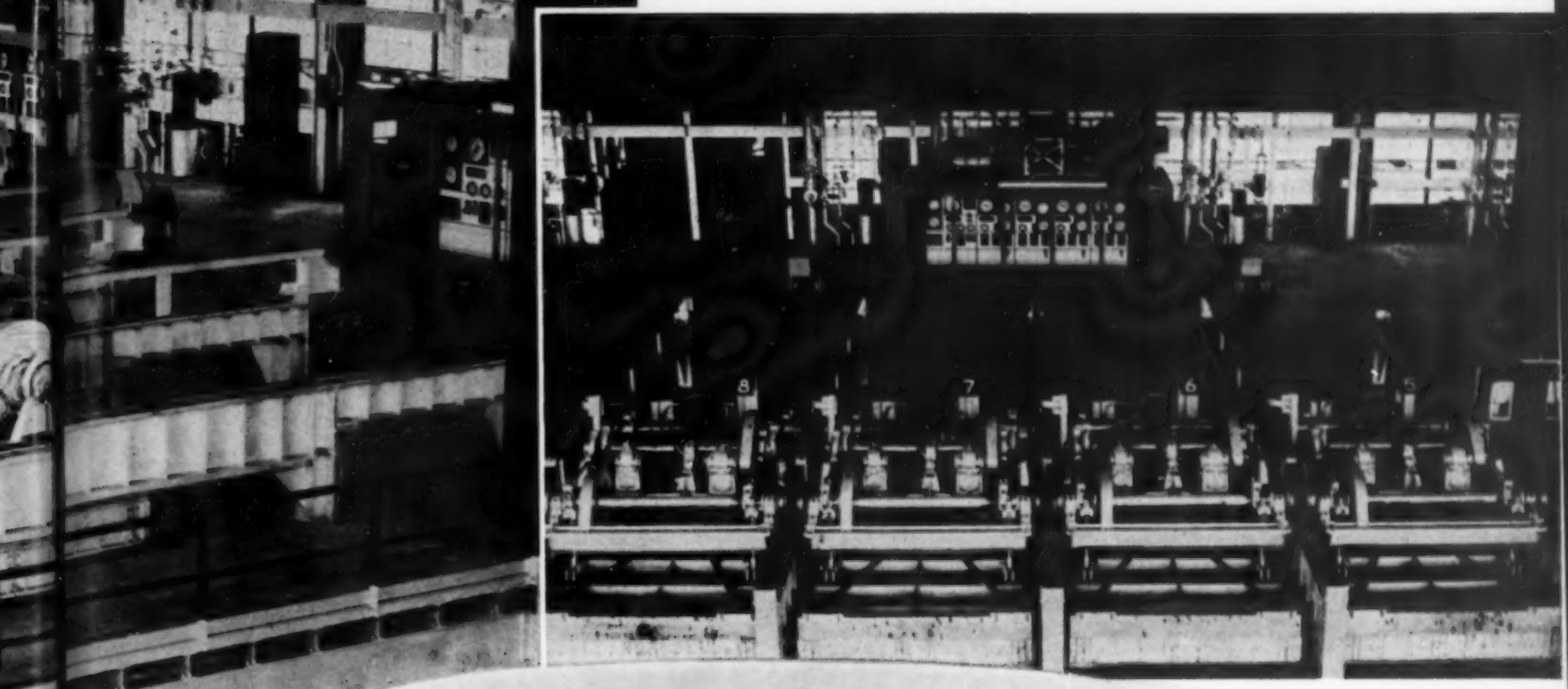
★ **ABOVE:** *Battery of 16 'Surface' One-Way Fired Soaking Pits used for the heating of ingots for rails.*



ABOVE: *View of control stands used for heaters inspection of the steel. For charging and discharging the pits, the covers are operated by the pit crane man from his crane cab, with an interlocking electrical control with the floor control operator. This minimizes the necessity of a floor operator for the covers, and saves time and heat since the pit crane man can operate the covers with greater cover movement flexibility.*

MODER

BELOW: *CONDITIONED AIR—brought in from the outside and filtered, is supplied to each control house. A ventilating air fan, located on top each control house, maintains an inside air pressure, resulting in an atmosphere that permits more exacting control by the instruments, and greater comfort for the operating personnel.*



OFFER GREATEST FLEXIBILITY OF OPERATION

by utilizing Many fuels

Outstanding among the many features of this battery of 'Surface' One-Way Fired Soaking Pits is the great flexibility of firing to meet any prevailing fuel supply. The pits normally utilize blast furance gas mixed with a small amount of coke oven gas as a fuel of approximately 130 Btu per cubic foot. However, firing automatically changes to coke oven gas once the supply of blast furnace gas drops below a certain amount. When blast furnace gas becomes plentiful, it automatically reverses. If all gas fails in entirety, the pits are manually changed to fire with oil.

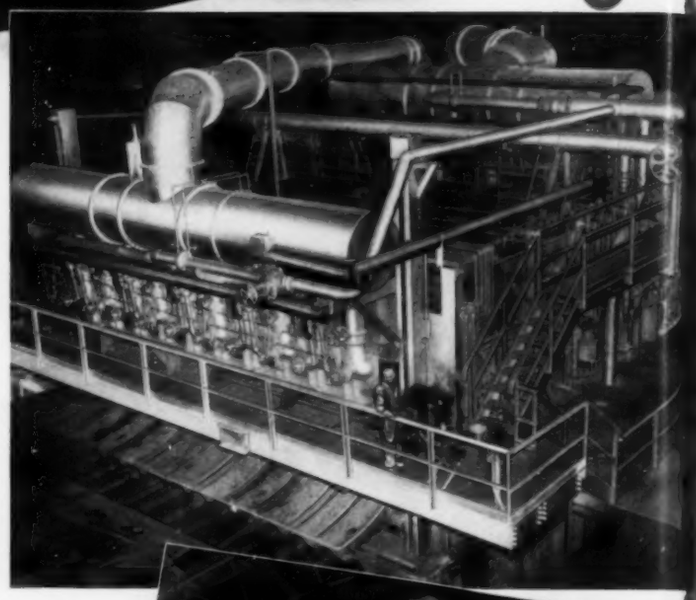
'Surface' One-Way Fired Pits can be operated on every type of fuel gas, coke oven gas, natural gas, producer gas, blast furnace gas, also on fuel oils and tars, and various combinations of fuels. This flexibility in fuel utilization requires scientific burner design, and features preheating of combustion air, efficient flame travel, automatic temperature and combustion control, adequate pit insulation, all to produce maximum thermal efficiency.

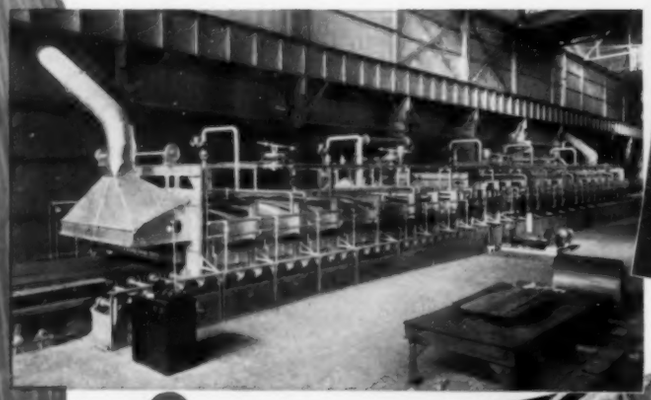
'Surface' ONE-WAY FIRED PITS

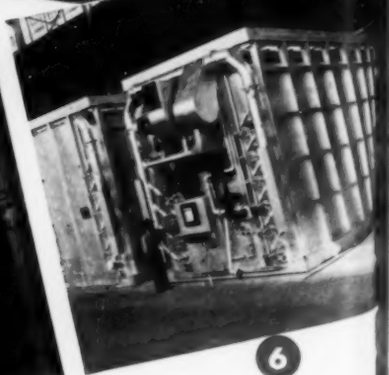
'Surface' SERVES WITH HEAT

FROM INGOT TO FINISHED PRODUCT

1. *Slab Heating Furnace*
2. *Continuous-type Annealing and Normalizing Furnace*
3. *Rod and Wire Annealing Covers*
4. *High Alloy Rod and Bar, Controlled Atmosphere Furnace for carbon correction*
5. *Prepared Gas Generating Equipment (RX, AX, NX, DX, and Char-Mo Gases*
6. *Coil and Sheet Annealing Covers*







It will pay you to discuss your heating and heat treating problems with a 'Surface' Engineer.

SURFACE COMBUSTION CORPORATION • TOLEDO 1, OHIO

PRODUCT Information

ON ANY OF THE PRODUCTS MENTIONED IN THIS ISSUE

Below is an index of products referred to in editorial and advertising pages of this issue. If you desire additional information on any of them, use one of the accompanying postcards in requesting it. In each case give name of product and page number. The information will come to you directly from the manufacturer involved.

PRODUCTS INDEX

Air filters 4
Atomizers 136

Batteries, storage 173
Bearings, ball 124
Bearings, roll neck 140
Bearings, roller tapered 10
Billet chippers 177
Blast furnace construction 159
Blowers 185
Boxes, charging 165
Brake shoe lining ..... Cover II
Breaker, circuit 153
Brushes, carbon 172
Buckets 129
Burners 164

Cable reels 126
Cables, insulated wires and 26, 155, 163
Carbon blocks 150
Castings, alloy steel 33
Castings, copper 138
Charts, metal identification 184
Circuit breaker 153
Cleaning of pipe 179
Coal and ore cleaning 138
Combustion controls 118, 128, 175
Concentrator, float-sink 138
Concrete, heat-resistant 120, 124
Conduits 119
Connectors 136
Construction, blast furnace 159
Controls, combustion 118, 128, 175
Controls, crane 3
Controls, electrical 187
Conveyors 12
Cooling towers 181
Copper castings 138
Couplings, flexible 18
Crane cab conditioner 124, 158, 172
Crane controls 3
Cranes 34, 132, 164
Cutting, oxyacetylene 144

Design and construction, steel plants 30
Diesel electric locomotives 13
Drive, adjustable speed 32
Drives, skip hoist 135
Drives, worm gear ..... Cover III
Duplexing 40

Ejector, gas 36
Electric arc furnaces 40

Finishing equipment, strip mill 1
Fitting, grease 37
Fittings 182
Furnaces 161
Furnaces, convector 167
Furnaces, electric arc 40
Furnaces, malleable 149
Furnaces, slab heating 126
Furnaces, tube and roller hearth 131
Fuses 115, 154, 156

Gas ejector 36
Gear drives, worm ..... Cover III
Grease fitting 37
Grinder, roll 169
Guides, mill 183

IRON AND STEEL ENGINEER April, 1948

Please send me additional products information as requested below:

Product and Page No. .....

" " " " .....

" " " " .....

Name .....

Title or Position .....

Company .....

Address ..... City ..... Zone .... State .....

Postage Will be Paid by Addressee

No Postage Stamp Necessary If Mailed in the United States

BUSINESS REPLY CARD

First Class Permit No. 1963, Sec. 510, P. L. & R. Pittsburgh, Pa.

IRON AND STEEL ENGINEER

1010 EMPIRE BUILDING

PITTSBURGH 22, PA.

PRODUCTS INDEX — (Continued)

Gun, paint spray....141

Indicator, temperature....130
Inhibitors....130
Instruments....118, 126, 128, 175
Insulated wires and cables....26, 155, 163

Lathes, roll....121
Locomotives, diesel electric.... 13
Lubricants....188, 190

Machine repair....168
Magnets, lifting....125, 134
Malleable furnaces....149
Marking machine....134, 143
Metal identification charts....184
Mill equipment, rolling.... 38
Mills, continuous hot strip....Cover I
Mills, rolling....6, 127
Motors, electric....8, 14, Cover IV

Nickel alloys....186

Oil, non-fluid....188
Oil seal....180
Oil, soluble.... 9
Oxyacetylene cutting....144

Paint spray gun....141
Peels....165
Pickler, mechanical....134
Pits, circular soaking.... 25
Pits, soaking.... 21
Plants, design and construction of steel . 30
Plate, cooling....136
Plugs and receptacles....171
Potentiometer....176
Pumps, horizontal centrifugal....142

Receptacles and plugs....171
Reducers, speed....166
Reels, cable....126
Refractories....137
Regulators, atmospheric....145
Relay....129
Resistors, plate....194
Resistors, steel grid.... 16
Roll grinder....169
Roll lathes....121
Roller bearings, tapered.... 10
Rollers, carburized tubular.... 28
Rolling mill equipment.... 38
Rolling mills....6, 127
Roll neck bearings....140

Rolls....2, 17, 27, 29, 139, 157, 174

Safety steel stamps....138
Seal, oil....180
Slitters, warehouse....170
Soaking pits.... 21
Soaking pits, circular.... 25
Soluble oil.... 9
Stamps, safety steel....138
Steel plants, design and construction.... 30
Straightener, I-beam....122
Strip mill finishing equipment.... 1

Timers, pneumatic.... 5
Towers, cooling....181
Transformers....146
Trucks, hand....125
Turboblowers....178

Valves....182
Valves, hydraulic....141
Valves, pump....189

Welding, submerged....130
Wheel, skip-numeral print....129
Wires and cables, insulated....26, 155, 163

IRON AND STEEL ENGINEER April, 1948

Please send me additional products information as requested below:

Product and Page No.....

" " " " .....

" " " " .....

Name.....

Title or Position.....

Company.....

Address..... City..... Zone.... State.....

Postage Will be Paid by Addressee

No Postage Stamp Necessary if Mailed in the United States

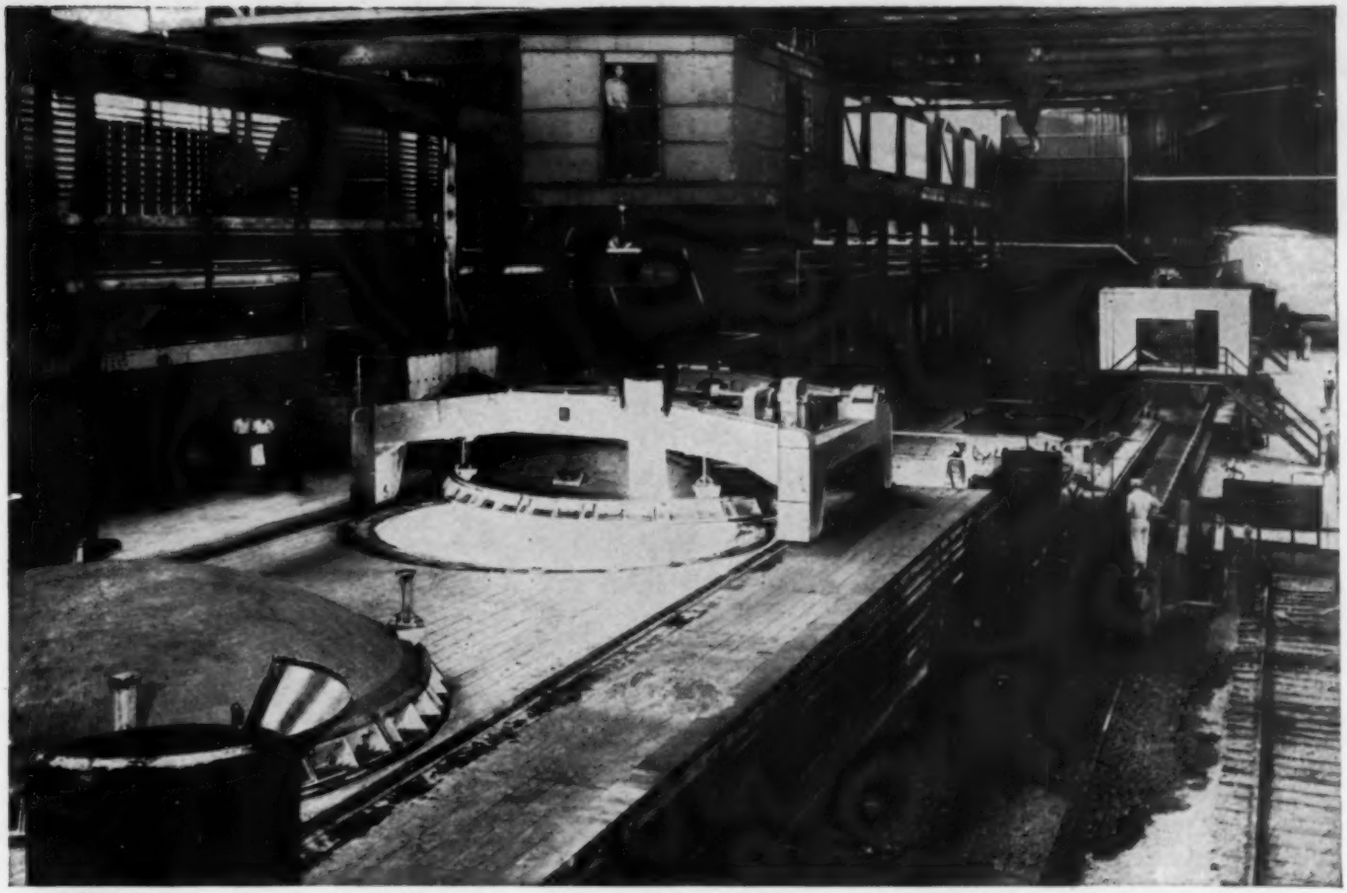
BUSINESS REPLY CARD

First Class Permit No. 1963, Sec. 510 P.L.&R. Pittsburgh, Pa.

IRON AND STEEL ENGINEER

1010 EMPIRE BUILDING

PITTSBURGH 22, PA.



THE SALEM CIRCULAR SOAKING PIT

... is designed and constructed for economy of operation and maintenance It has the inherent strength of a circular section and develops a strong keying action throughout the brick wall. (Space consuming, heavy buckstays are eliminated.) The cover is supported on the sand seals, forcing the seal lips deeply into the sand and assuring an effective seal. Sand seal troughs are supported directly on the furnace shell, *not* on the brick work.

Illustrated is a typical circular pit installation where operating records prove that tonnages produced per unit of area exceed those of other types of heating equipment under comparable conditions.

SALEM ENGINEERING CO. · SALEM, OHIO
SOUTHWEST OFFICE · FORT WORTH, TEXAS
SALEM ENGINEERING CO. (Canada) Ltd., TORONTO
SALEM ENGINEERING CO. · SHEFFIELD, ENGLAND

P-6

SALEM

ALL OFFICES STAFFED FOR . . ENGINEERING, CONSTRUCTION and OPERATION

Salem Builds

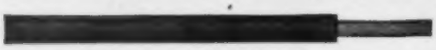
CIRCULAR SOAKING PITS
ROTARY HEARTH FURNACES
CONTINUOUS BUTT-WELD FURNACES
CAR BOTTOM FURNACES
FORGE FURNACES
HEAT TREATING FURNACES
NEEDLE METALLIC RECUPERATORS
AIR RECIRCULATING FURNACES
GAS ATMOSPHERE FURNACES
MECHANICAL EQUIPMENT FOR CHARGING AND DISCHARGING MATERIAL FROM FURNACES

PERMANENTLY INSULATED TO RESIST HEAT FUMES - OIL - GREASE - MOISTURE - FLAME

From the three basic designs illustrated Rockbestos has developed a complete line of 125 failure resisting wires, cables and cords, a few of which are described. All have the same performance guaranteeing characteristics detailed below. Write for a catalog or samples.

Rockbestos Permanent Insulation Insures Long-Lived Service

1. A tough impregnated asbestos braid, resistant to heat, flame, moisture, oil, grease, alkalies and corrosive fumes.
2. Felted asbestos insulation impregnated with heat, flame and moisture resisting compounds will not dry out with age, burn, or bake brittle under high temperatures.
3. Lubricated varnished cambric for high dielectric strength and added moisture resistance — protected from heat, flame and oxidation by felted asbestos walls.
4. Impregnated asbestos insulation that withstands heat of overloads and aging and won't become brittle, crack, rot or burn.
5. Conductors are perfectly centered in helically applied non-flowing insulation and will always remain so.



ROCKBESTOS 300 VOLT HEAT RESISTING FIXTURE WIRE
(Underwriters' Type AF)
Sizes No. 10 to 18 AWG stranded plain copper conductor insulated with black or white impregnated felted asbestos—with or without braid.

Rockbestos asbestos insulated fixture wires, approved by the Underwriters' Laboratories for lighting fixture wiring, will not bake out under the high socket temperatures developed in modern high-wattage fixtures. Also used for small motor and apparatus leads, switchboards, etc.

ROCKBESTOS A.V.C. 600 VOLT SWITCHBOARD WIRE
(National Electrical Code, Type AVB)
Sizes No. 18 to No. 4/0 AWG with varnished cambric and impregnated asbestos insulation and gray, black, white or colored flameproof braid.

Combine fire insurance and fine appearance in your switchboards with flame and heat resistant Rockbestos A.V.C. Switchboard Wire. Takes right angle bends without cracking because asbestos wall acts as a cushion beneath braid. Rockbestos A.V.C. Hinge and Switchboard Bus cables have same characteristics.

ROCKBESTOS A.V.C. 600 VOLT POWER CABLE
(National Electrical Code, Type AVA)
Sizes No. 18 AWG to 2,000,000 CM insulated with laminated felted asbestos, varnished cambric, and asbestos braid. Other constructions for service voltages to 5000.

This cable is recommended for power leads of heat-exposed equipment and circuits that run near boilers, steam lines, furnaces, kilns and other hot spots. It withstands high ambient and conductor temperatures and has ample moisture resistance.

ROCKBESTOS A.V.C. 600 VOLT CONTROL CABLE
In one to 19 conductors with individuals insulated like Motor Lead Cable, cotton braid covered and cabled with an asbestos braid over all. Standard strandings AWG No. 12—19/#25 and No. 9–19/#22. Other strandings on order.

Designed for applications requiring a multi-conductor control cable capable of withstanding high temperatures, corrosive fumes, oil, grease and moisture. It also eliminates fire hazard as it will not burn. Used by equipment manufacturers, power companies, steel mills.

ROCKBESTOS A.V.C. 600 VOLT BOILER ROOM WIRE
(National Electrical Code, Type AVA)
Sizes No. 18 to 8 AWG insulated with varnished cambric, impregnated felted asbestos and asbestos braid. Sizes 6 to 4/0 have another wall of felted asbestos next to the conductor.

For lighting and control circuits exposed to heat and moisture, oil, grease, corrosive fumes or fire hazard around furnaces, ovens, lehrs, soaking pits, boilers, etc., this permanently insulated wire is ideal. It won't bake brittle, crack, rot, flow or swell.

ROCKBESTOS THERMOSTAT CONTROL WIRE
Sizes No. 14, 16 and 18 AWG in two to five conductors with .0125", .025" or (for 115 volt service) .031" of impregnated felted asbestos insulation and steel armor.

A multi-conductor wire for fuel burner controls, safety pilots, intercommunications and signal systems. Heatproof, fireproof insulation and steel armor give trouble-proof circuits.

ROCKBESTOS A.V.C. 600 VOLT MOTOR LEAD CABLE
(National Electrical Code, Type AVA)
Size No. 18 AWG to 1,000,000 CM insulated with two walls of impregnated asbestos and a high-dielectric varnished cambric insert, with a heavy asbestos braid overall.

Use this apparatus cable for coil connections, motor and transformer leads exposed to overloads or high ambient temperatures. It makes a permanent installation as it is resistant to heat, flame, oil, grease and moisture.

ROCKBESTOS ASBESTOS INSULATED MAGNET WIRE
Round, square and rectangular asbestos insulated conductors finished to meet varying winding conditions and coil treatment requirements.

Protect motors against heat-induced breakdowns with Class B windings of heat resisting magnet wire. Rockbestos A.V.C. Motor Lead Cable completes the failure-proofing.

ROCKBESTOS 300 VOLT HEAT RESISTING DUPLEX FLEXIBLE CORD
(Underwriters' Type AFPD)
Sizes No. 10 to 18 AWG stranded plain copper conductors insulated with impregnated felted asbestos, polarized, twisted together and covered with a cotton braid.

This heat-resisting cord is approved for use in lighting fixtures and is recommended for pendant types as it does not dry out or crack at the socket. Also on apparatus and appliances which develop heat in operation or are used in hot, dry places. Twisted pair, tripled or triplex constructions also available.

ROCKBESTOS A.V.C. 600 VOLT FLEXIBLE CORD
Sizes No. 10 to 18 AWG with two or three conductors insulated with impregnated felted asbestos, varnished cambric, felted asbestos, covered with heavy impregnated asbestos braid.

A heavy duty, high-dielectric, heat and moisture resistant flexible cord used in locomotive cab circuits, high wattage lighting units, floodlights and for leads on apparatus exposed to heat. Specify polarized conductors if desired. For high temperature applications where resistance to moisture is not required specify All-Asbestos insulated constructions.

ROCKBESTOS ALL-ASBESTOS 600 VOLT RHEOSTAT CABLE
(National Electrical Code, Type AIA)
Sizes No. 18 AWG to 1,000,000 CM insulated with a heavy wall of felted asbestos, covered with a rugged asbestos braid finished in black, white or colors.

Use this cable for wiring rheostats, switchboards, elevator and locomotive control panels and equipment exposed to heat, fumes or fire hazard — also for open power circuits in hot, dry locations. For flexible conductor specify Rockbestos All-Asbestos Flexible Apparatus Cable — for solid conductor, Rockbestos All-Asbestos Rheostat Wire.

WRITE NOW FOR
Your copy of the new No. 10-F Catalog

ROCKBESTOS PRODUCTS CORPORATION
626 NICOLL ST., NEW HAVEN 4, CONN.

NEW YORK BUFFALO CLEVELAND DETROIT
CHICAGO PITTSBURGH ST. LOUIS
LOS ANGELES OAKLAND, CAL.

This rolls out the dough..

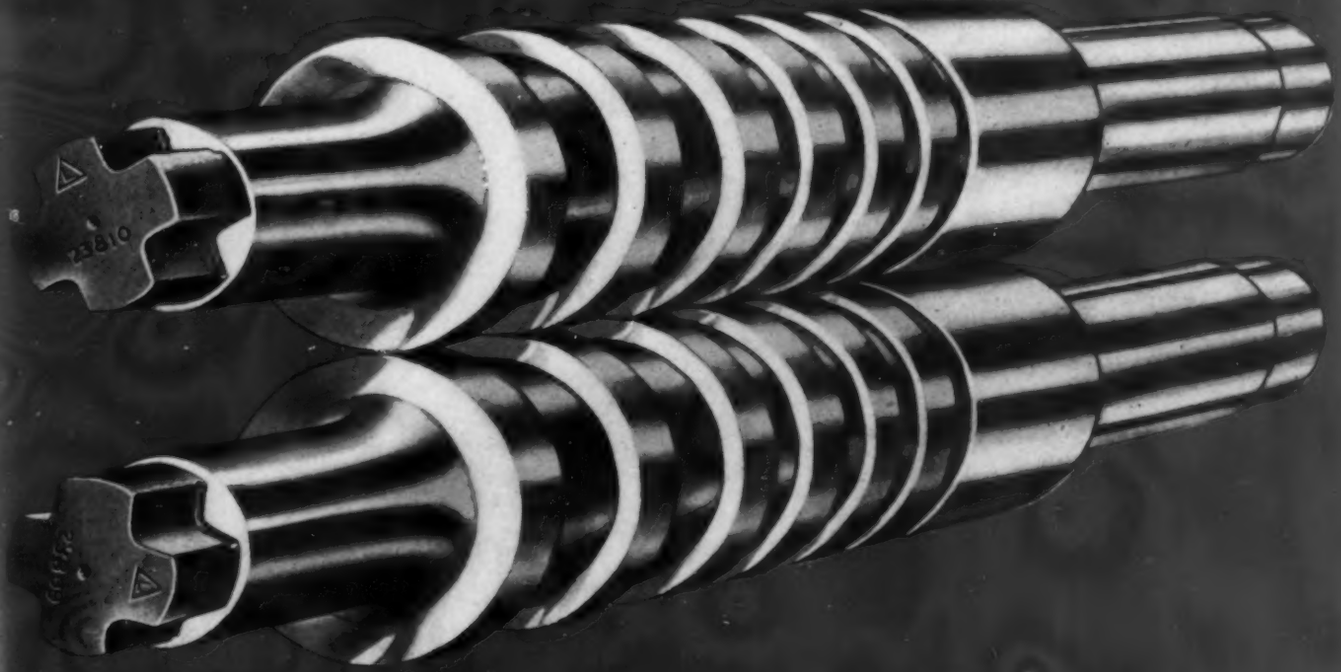
LEWIS ROLLS IT IN!

Bigger "bites," greater reductions, higher speeds, longer useful life—those are the things that determine the value of your roll investment and the profit on your finished products.

And those dollars-and-cents facts are well known to Lewis roll designers and metallurgists. They team-up to provide you with rolls that insure greater net profit per ton and per year.

LEWIS FOUNDRY & MACHINE
Division of Blaw-Knox Co.
Pittsburgh, Pa.

ALSO MANUFACTURERS OF
ROLLING MILL MACHINERY
FOR THE IRON, STEEL AND
NON-FERROUS
INDUSTRIES



LEWIS ROLLS

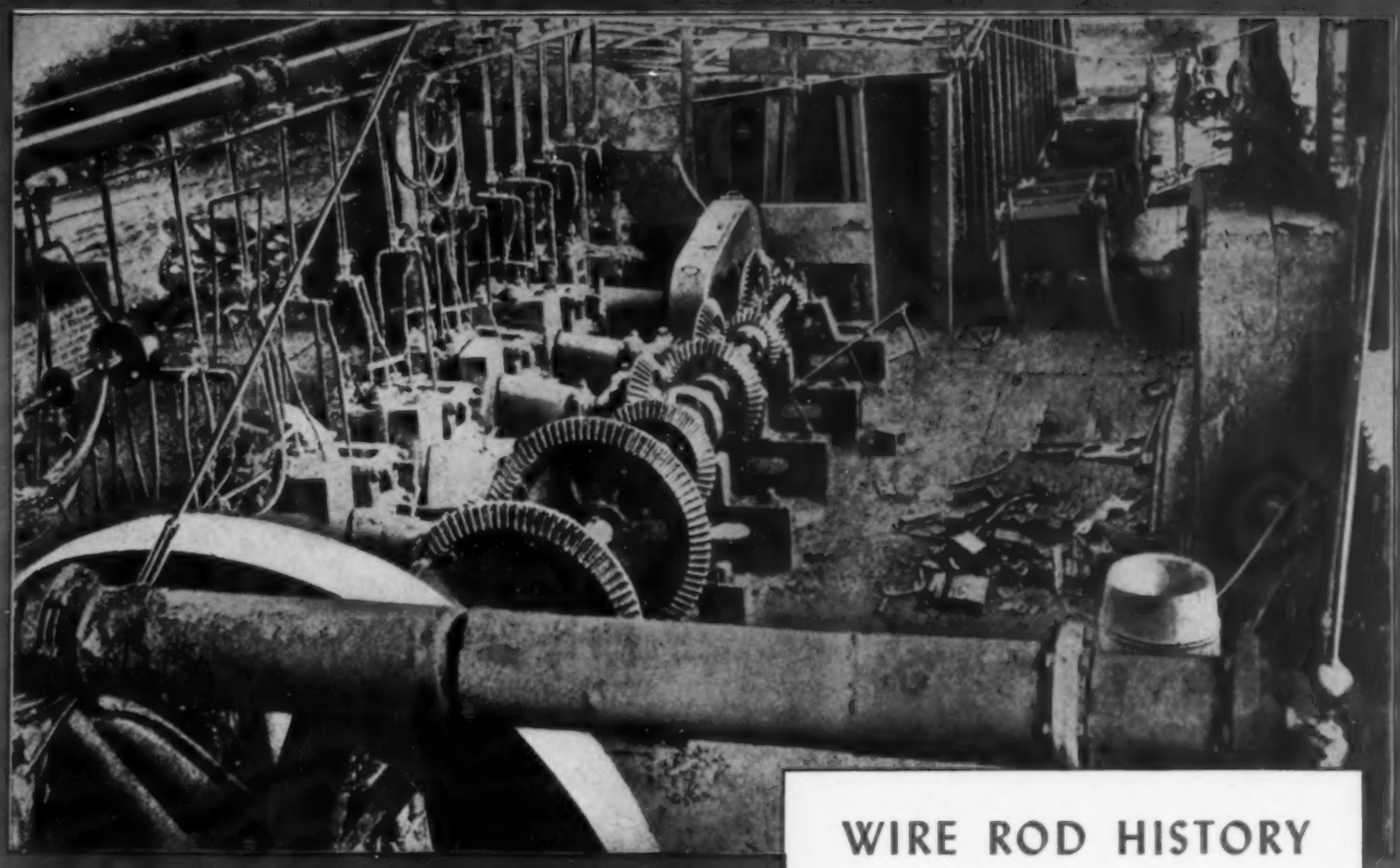
A Million Tons

OF HOT STEEL OVER THESE CARBURIZED TUBULAR ROLLERS NONE CHANGED

Send for Bulletin No. 743-19

BADALL ENGINEERING & MANUFACTURING CO.

Hammond, Indiana



BEDSON WIRE ROD MILL—PATENTED, 1862. USED UNTIL LATE NINETY'S.

WIRE ROD HISTORY

1700 B. C —Earliest known use of wire.

1751 A D —Oliver slitting mill built.

1783—Cort patented grooved rolls.

1839—First wire rod mill in U.S.A.

1842—First continuous wire rod mill.

1860—Crinoline wire and hoop skirts.

1862—Bedson continuous mill patented.

1868—Hunt patented barbed wire.

1882—First Garret rod mill built.

1884—First loom-woven fencing made.

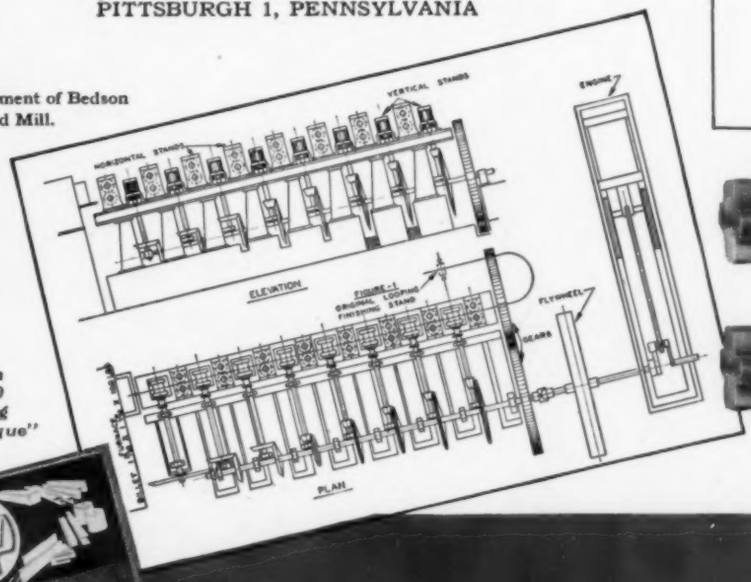
1892—Wire nail production first exceeded cut nails.

The Wire Rod Mill gave us farm fences, screened homes, and made possible the tremendous development of the electrical age.

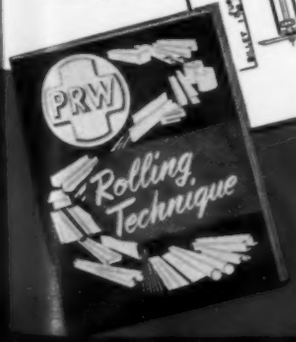
Phoenix Rolls contributed to the development of the modern wire rod mill by giving *more production at less cost per ton of steel rolled.*

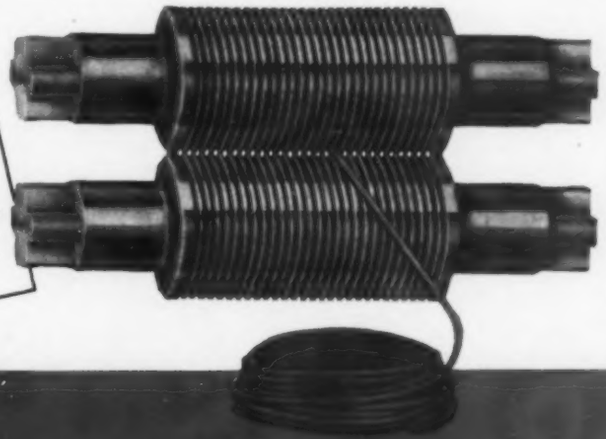
PITTSBURGH ROLLS
DIVISION OF BLAW-KNOX COMPANY
PITTSBURGH 1, PENNSYLVANIA

Arrangement of Bedson Wire Rod Mill.



Ask for Bulletin No. 2090 "Rolling Technique"





PITTSBURGH ROLLS

NUMBER 16 IN A SERIES OUTLINING McKEE SERVICES TO THE IRON AND STEEL INDUSTRY IN RECENT YEARS

SUMMARY

ESTABLISHED in 1905, Arthur G. McKee & Company's experience covers more than four decades of design and construction of the Iron and Steel Industry's production facilities from raw material to finished steel.

The following facts and figures briefly summarize the major iron and steel plant engineering activities of the McKee organization during the past fifteen years.

BLAST FURNACES

In the 10 years between 1936 and 1947 McKee designed and constructed 26 Blast Furnaces. More than half of these included stoves, cast houses, stock houses and gas cleaning equipment.

The 26 furnaces increased the industry's capacity by more than 7½ million net tons annually.

The total erected value of these projects exceeds 100 million dollars.

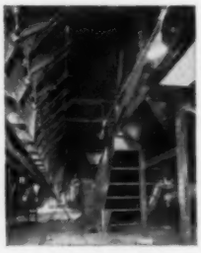
McKee work in process in 1948 includes 5 blast furnaces in the United States and 4 in England. 3 of the domestic furnaces, which will be in operation by early summer, have 28-foot hearth diameters.

HOT BLAST STOVES

Since 1935 the McKee organization has designed and constructed 118 hot-blast stoves.

The largest and most modern of these stoves have 28-foot inside diameters and a height of 133 feet, 6 inches. Each stove has a heating surface of 290,295 square feet.

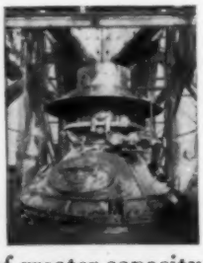
STOCK HOUSES



33 blast furnaces have been equipped with McKee Stock Houses in recent years.

Incorporating the most modern methods of automatic coke-charging, up-to-date features of design and latest equipment, these stock houses provide maximum operating efficiency.

BLAST-FURNACE DISTRIBUTORS



McKee has furnished more than 390 revolving distributors for blast furnaces in the United States and other countries. Mechanical dependability and rugged design have made them standard equipment throughout the United States and the British Empire.

A new type McKee distributor of greater capacity and more massive construction is meeting the requirements of the new 28-foot-hearth-diameter furnaces and older furnaces operating at high top pressures. Details are available upon request.

McKEE

DESIGN, ENGINEERING AND CONSTRUCTION

OPEN HEARTH PLANTS

McKee Open Hearth engineering included foreign and domestic contracts ranging from supervision of rebuilding to design, engineering and construction of complete plants ready for operation. Total annual capacity of the 25 units involved is over 2 million tons.

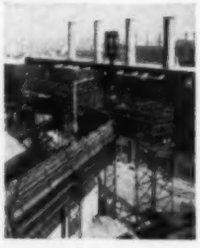
FACILITIES FOR TREATING RAW MATERIALS

Contracts in this classification included design and construction of plants for concentrating, sizing, blending and the agglomerization of iron ores.

The bedding system for accurate blending of iron ores was initiated by McKee.

Facilities built by Arthur G. McKee & Company for the beneficiation of specific ore deposits in Europe are the most complete and among the largest ore treating plants in the world.

POWER HOUSES



Recent McKee activities include design and construction of 18 power houses. More than half are in operation—the balance being in various stages of completion.

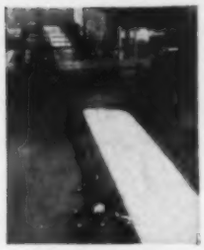
These power houses were designed to operate turbo blowers for blast furnaces, to generate operating power, to provide process steam for petroleum refining and miscellaneous industries and for general steam purposes.

Combined capacity of the 18 plants is over 5½ million pounds per hour of steam generated.

SPECIAL SERVICES

In recent years McKee organization has supplied special services on numerous individual problems involving remodeling and alteration of existing facilities to accommodate changes in operating practice, to reduce operating cost, or to increase production.

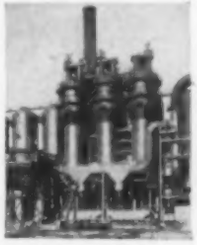
ROLLING MILL PLANTS



Contracts executed include design and construction of Blooming Mills, Plate Mills, Billet Mills, Rail and Structural Mills, Merchant Mills, Strip Mills, Cold Mills, and Tin Mills.

Typical examples of outstanding McKee design are two foreign projects, one incorporating 10 mills, the other 6 mills, a 112″—3-high and a 120″—4-high plate mill recently completed in this country.

REPLACEMENT, MODERNIZATION AND REHABILITATION



Aside from major projects McKee has undertaken separate contracts totalling over 20 million dollars for blast-furnace and stove relining, modernization of existing units, repairs of all kinds, steel mill foundations, miscellaneous steel plant buildings and structural work, secondary centrifugal dust catchers, stoves, thickeners, sludge handling, fine gas cleaning and distribution equipment.

ANALYSIS AND CONSULTATION

Practically all of the larger American iron and steel producing companies have repeatedly used McKee consulting services.

McKee clients also include the governments of the United States, Canada, Brazil and China as well as many private companies in these and other foreign countries.

McKee maintains a large staff of qualified consultants for the study and analysis of markets, quality of steel needed, nature of raw materials available and of beneficiation required, and for the adaptation of equipment and processing procedures best suited for meeting these conditions.

The volume of engineering and construction entrusted to this organization is an indication of the confidence which has been earned by McKee in four decades of service to the Iron and Steel Industry.

ARTHUR G. McKEE & COMPANY

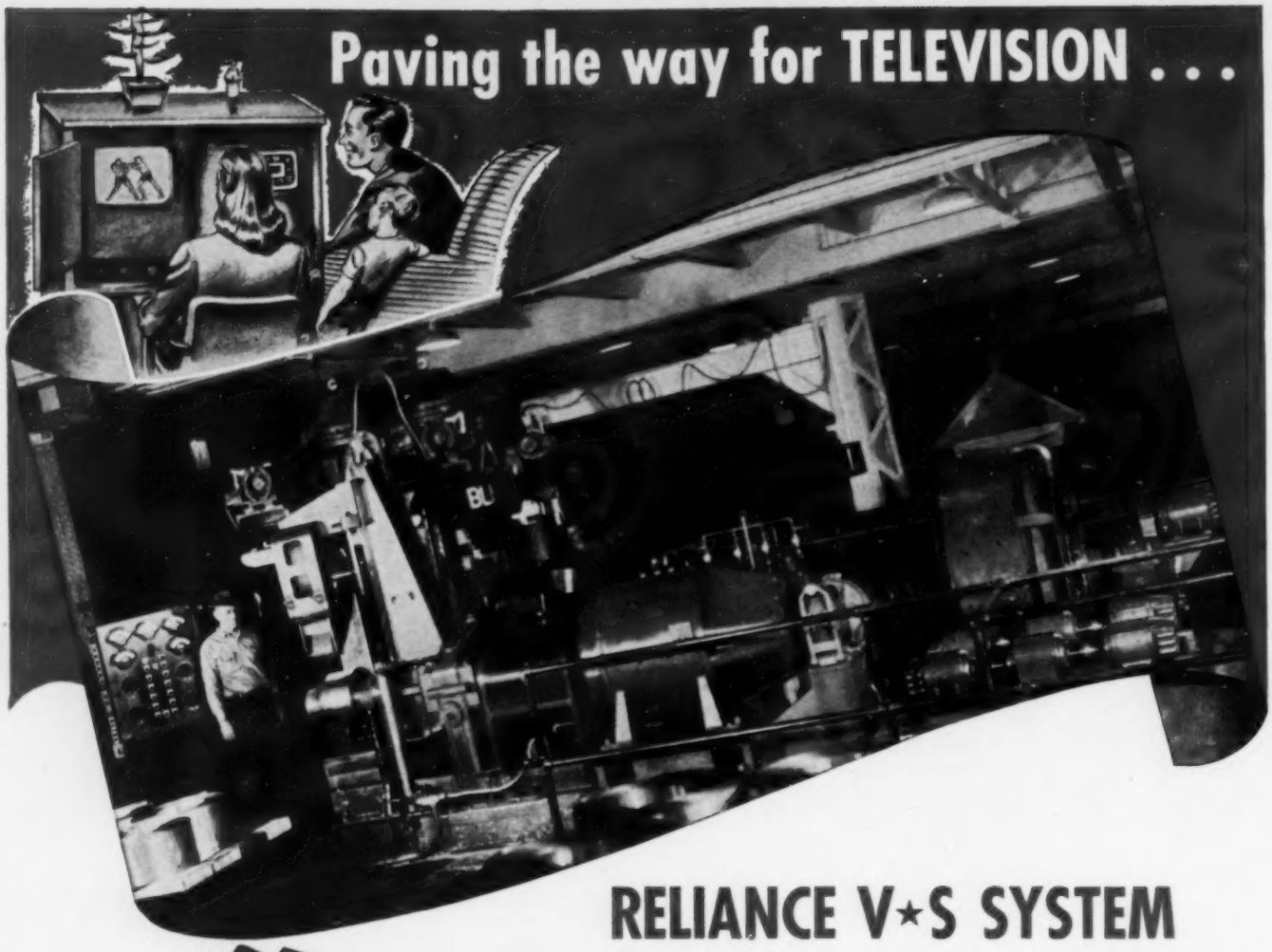
Engineers and Contractors • Established 1905

2300 Chester Avenue • Cleveland, Ohio • 30 Rockefeller Plaza • New York, N. Y.

The Iron & Steel Division of Arthur G. McKee & Company is associated in England with McKee Iron & Steel Division of HEAD, WRIGHTSON & CO., LTD.

FOR THE IRON AND STEEL AND PETROLEUM REFINING INDUSTRIES

UNDIVIDED RESPONSIBILITY IN ONE ORGANIZATION



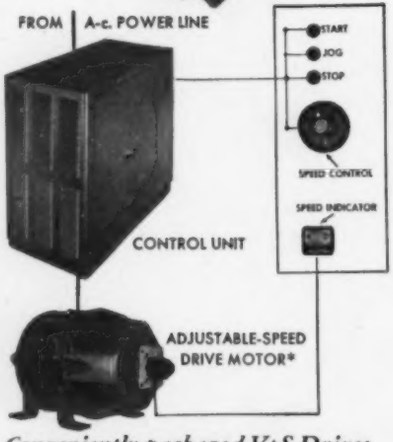
RELIANCE V★S SYSTEM

provides Adjustable Speeds from A-c. Circuits

Coaxial cables that will carry a television program requiring a frequency range of up to 6,000,000 cycles must be precision-made in every detail. So the Reliance V★S System is used for quick, accurate, wide-range speed control in rolling the copper tape outer conductor. The advantages of the V★S System in this and other applications in this new field are being demonstrated daily.

For further information on stepless speed changing—and facts about quick, smooth starting and stopping, maintenance of proper tension and other V★S functions that help improve production and cut costs, write today for the *new* Bulletin 311.

RELIANCE V★S DRIVE



Conveniently-packaged V★S Drives are available from 1 to 200 hp.

**Two or more motors may be operated simultaneously from a single Control Unit.*

RELIANCE ELECTRIC & ENGINEERING CO.

1084 Ivanhoe Road • Cleveland 10, Ohio

Appleton, Wis. • Birmingham • Boston • Buffalo • Chicago • Cincinnati • Dallas • Denver • Detroit • Gary Grand Rapids • Greenville, S. C. • Houston • Kansas City • Knoxville • Little Rock • Los Angeles • Milwaukee Minneapolis • New Orleans • New York • Omaha • Philadelphia • Pittsburgh • Portland, Ore. • Roanoke, Va. Rockford • St. Louis • San Francisco • Seattle • Syracuse • Tampa • Tulsa • Washington, D. C. Mexico City, Mexico • Montreal, Canada • Sao Paulo, Brazil

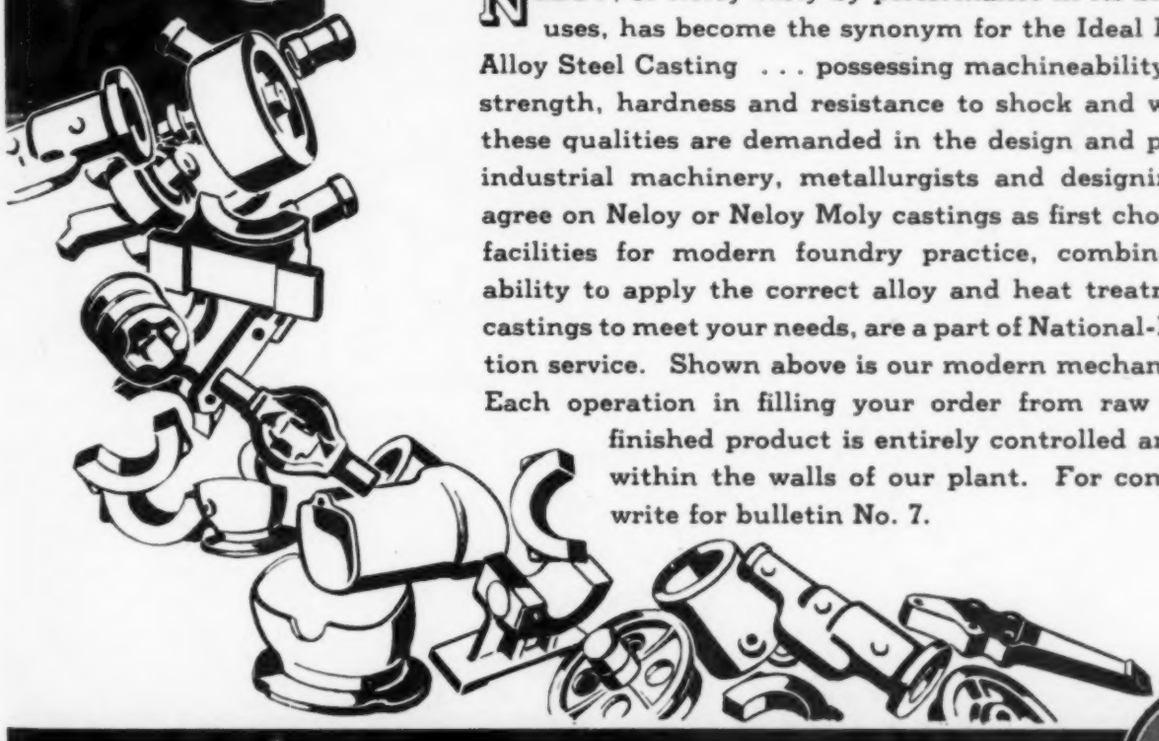
RELIANCE A-C D-C MOTORS

"Motor-Drive is More Than Power"

Alloy Steel Castings of

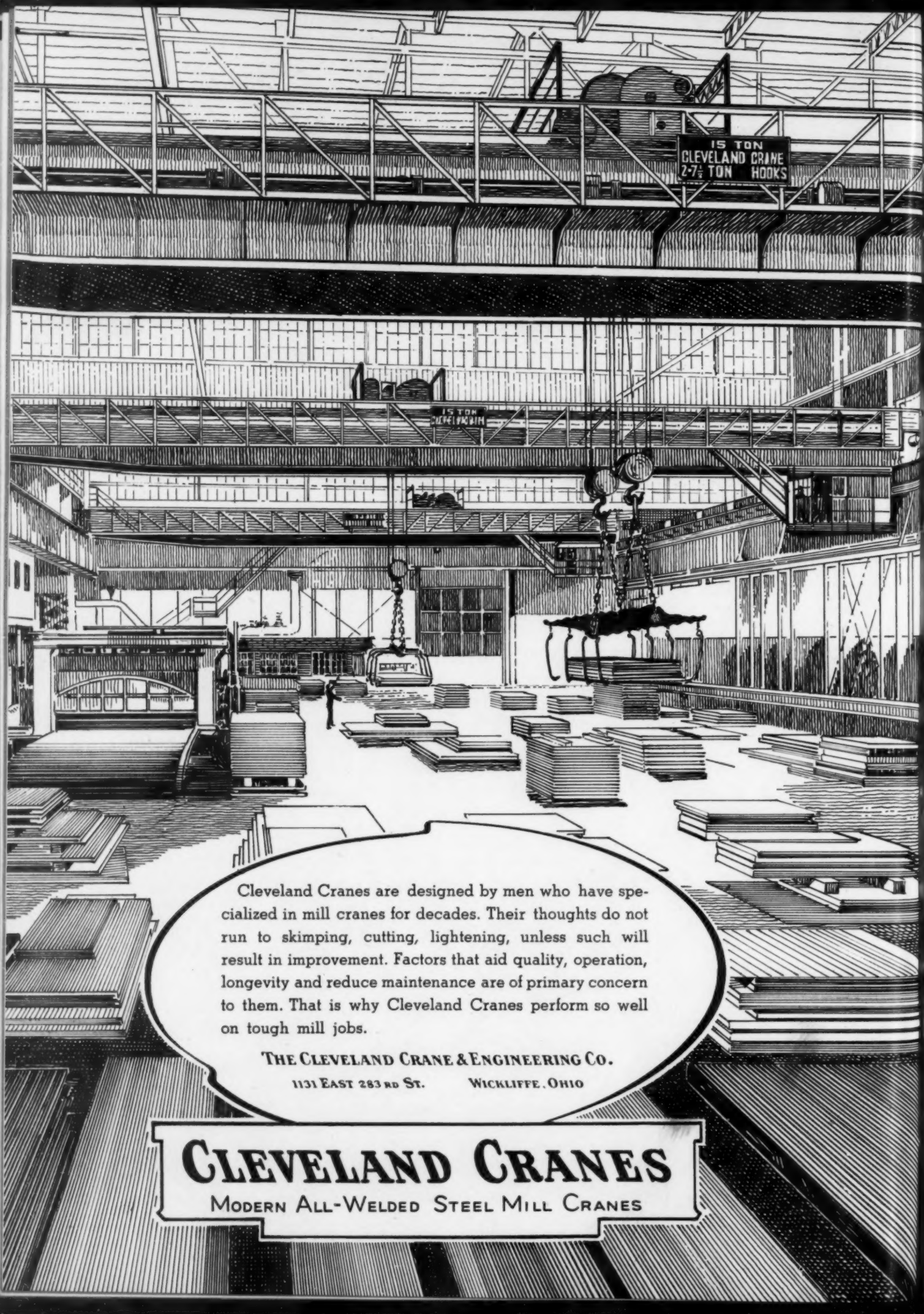
Neloy (and Neloy Moly) . . . Preferred by Industry

NELOY, or Neloy Moly by performance in its broad range of uses, has become the synonym for the Ideal Heat Treated Alloy Steel Casting . . . possessing machineability, toughness, strength, hardness and resistance to shock and wear. Where these qualities are demanded in the design and production of industrial machinery, metallurgists and designing engineers agree on Neloy or Neloy Moly castings as first choice. Modern facilities for modern foundry practice, combined with the ability to apply the correct alloy and heat treatment of steel castings to meet your needs, are a part of National-Erie Corporation service. Shown above is our modern mechanical foundry. Each operation in filling your order from raw materials to finished product is entirely controlled and completed within the walls of our plant. For complete details write for bulletin No. 7.



NATIONAL ERIE CORPORATION

ERIE, PENNSYLVANIA • U. S. A.



Cleveland Cranes are designed by men who have specialized in mill cranes for decades. Their thoughts do not run to skimping, cutting, lightening, unless such will result in improvement. Factors that aid quality, operation, longevity and reduce maintenance are of primary concern to them. That is why Cleveland Cranes perform so well on tough mill jobs.

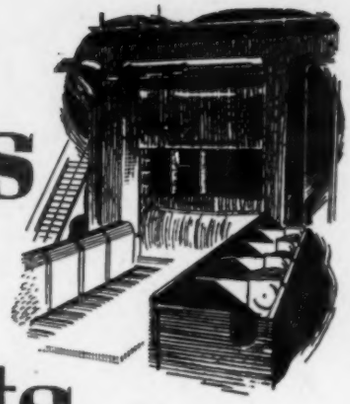
THE CLEVELAND CRANE & ENGINEERING CO.

1131 EAST 283 RD ST. WICKLIFFE, OHIO

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

Crops and Shorts



ALTHOUGH steel industry coal piles were larger at the start of the coal strike than in previous instances, the strike may eliminate the possibility of a new all-time record for steel production in 1948. With its capacity high, and with some assurance of peace in its own labor field, the steel industry hoped to better the 89,641,600 ton production of 1944.

It is too bad that a power-drunk labor leader can thus aggravate shortages and stymie the flow of badly needed material, particularly at the exact time when the world conditions indicate we should perhaps be getting set for stormy weather.

John L. Lewis would scoff at the idea of his being a communist, but his actions are definitely giving encouragement to that element. It has been said that reports going back to Moscow say the United States is so divided on its domestic problems that it could not get together to meet a foreign crisis. We could scarcely blame Russia, already misled by these reports, for arriving at the fallacious conclusion that if the United States cannot control one of its own citizens, its opposition to aggression need not be feared. And such thinking might lead to rash acts.

Big industry has often been criticized for alleged disregard of the public good. What can we call this action on the part of big labor?

▲

IN order to complete our file of bound volumes of the IRON AND STEEL ENGINEER, we have need of a set of the magazine issues for 1924. If any of our readers have these issues, or know where we might obtain them, we would appreciate their letting us know.

▲

GOVERNMENT economists are rather at a loss to explain what became of one billion dollars that disappeared from circulation since Christmas. If we didn't know women's spending habits, we'd say it was lost in those packing cases they carry around on their arms.

▲

SEVERAL of the large steel producers have been combing various foreign areas for steel scrap. Bethlehem Steel Company has already imported approximately 1,000,000 tons from China, bringing it to United States ports at a cost below prevailing scrap prices. At least one other company has scouts out on the trail of "battlefield" scrap.

IN the Saturday Evening Post, an article by Robert M. Yoder says: "At 40 you are old enough to realize that you would look silly doing things you are still young enough to wish you could do."

▲

ALTHOUGH a lot of squawks have been leveled at the steel industry for failure to give all of their customers enough steel, two important groups of customers — railroad car and farm equipment builders — seem to prefer the industry's voluntary allocations to possible government allocations. At least, they wish to go on under present practices, thinking, perhaps, that things are never so bad that they couldn't be worse.

▲

NEWS item in an Alaskan paper: "Mrs. Fahlman has entirely recovered from her broken collarbone, but her knee is still in the hands of the doctor."

Another item in a California paper: "The area in which Miss G----- was injured is spectacularly scenic."

▲

IN view of what has happened to Czechoslovakia, we can't help but recall the reassurances of various visitors to our office from that country, who in all sincerity told us that their country couldn't possibly become communistic. These individuals, of course, were basing their thinking on their knowledge of their own people, and did not take into account the insidious infiltration and aggressive tactics of their neighbor to the east. Certainly, here is a warning to us not to be misled by "it-can't-happen-here" complacence.

▲

INDIVIDUALS who think that the life of an investor is all coupons and champagne might well study some statistics from the automotive industry. Its history shows that, of 816 different makes of automobiles brought out in the past only 25 are still made.

A lot of the wrinkles in business men's faces are trademarks.

▲

A SURVEY published by National City Bank of New York shows profits of 960 manufacturing concerns in 26 industries. The total list showed profits for 1947 approximately 50 per cent higher than in 1946. The steel industry, with an 11.3 per cent profit on invested capital, was 5.8 per cent below the average of all industries. Cotton textile companies netted 40 per cent on invested capital.

▲

A BANKER has been defined as a man who, when the sun is shining, will loan you, for a fee, an umbrella he doesn't own, and ask for it back at the first sprinkle of rain.

▲

IF the coal strike persists, we may have to adopt England's practice of issuing publicity to instruct people on coal conservation. One of the British government's instructions was: "Owing to the shortage of fuel, employers are asked to take advantage of their typists between the hours of 12 and 2."

the Morgan Ejector

—an economical, efficient, quick way to expel hot gases

- **Economical**...needs no costly stack and foundation, little maintenance.
- **Efficient** . . . Produces higher draft, maintains it at any volume, gets the most from any combustion equipment.
- **Quickly Installed**...No waiting for extensive alterations, gets the furnace back in operation with little delay.

Handles dust laden air, chemical fumes and gases that foul other systems. Ideal for use around airports. Stack is short. Creates no dangerous up-drafts because hot gases are mixed with cool air before being expelled.

Write us about your problem.

Pittsburgh, Pennsylvania
2815 Koppers Building

English Representative:
International Construction Company
56 Kingsway,
London W.C. 2, England

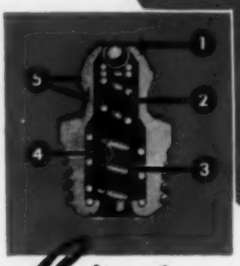
CCC-11

MORGAN CONSTRUCTION COMPANY - Worcester, Massachusetts

Announcing the New and Improved

LINCOLN
KLEENSEAL FITTING
BULLNECK TYPE

The Modern Fitting with a BALL IN THE TOP...



Check **These Features:**

1. **Flush Ball Check**—Head can be wiped clean without forcing dirt into fitting and into bearing.
2. **Large Grease Passage**—The larger internal diameter permits greater flow of lubricant.
3. **Special Spring Design**—Spring cannot be compressed to restrict flow of the heaviest lubricants.
4. **Greater Flow—Less Resistance**—The larger internal area requires less pressure to clear the fitting.
5. **Sturdier Construction**—Enlarged neck size and projecting locking pad protect against damage and wear.

These Grease Fittings (Bullneck Type), were originally developed by the Lincoln Engineering Company for the United States Army Ordnance Department. They incorporate the most desirable characteristics of former types of high-pressure fittings and permit standardization of one, all-purpose fitting (Bullneck Type). They represent the first major improvement in grease fitting design that does not obsolete couplers and grease guns in general use today—they can be securely contacted by all commercial hydraulic couplers.

Efficient lubrication is the means for CUTTING COSTS and getting GREATER PRODUCTION. Ask your Wholesaler about Lincoln Lubricating Equipment—Everything from Grease Fittings to Complete, Automatic, Centralized Lubricating Systems.

SALES AND SERVICE OFFICES

NEW YORK—Lincoln Lubricating Systems, Inc.—Trafalgar 7-7900
CHICAGO—Lincoln Engineering Co., of Ill.—Calumet 6022
DETROIT—Lincoln Engineering Co.—Madison 3484
PITTSBURGH—Lincoln Engineering Co.—Montrose 1444
LOS ANGELES—Lincoln Engineering Co., of Calif.—Richmond 0151
CLEVELAND—Lincoln Lubricating Systems, Inc.—Express 4334
OAKLAND—Lincoln Engineering Co., of Calif.—Higate 6130
EAST ORANGE—Lincoln Lubricating Systems, Inc.—Orange 3-3188

Distributors in All Principal Cities

LINCOLN ENGINEERING COMPANY • ST. LOUIS 20, MO.
Leaders in Lubricating Equipment for a Quarter Century

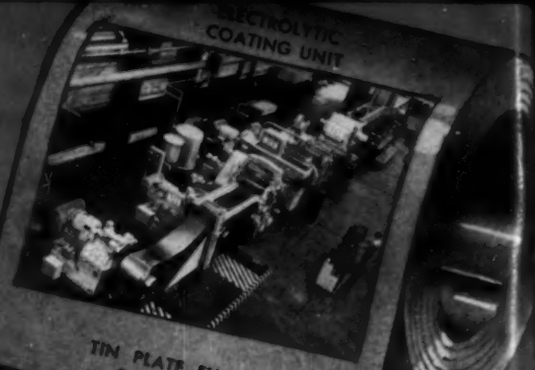
LINCOLN

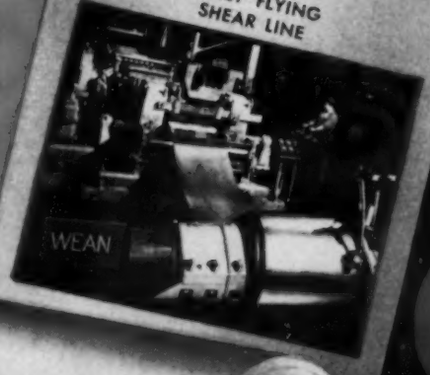
848-11

• APPLY THE RIGHT LUBRICANT
• IN THE RIGHT QUANTITY
• AT THE RIGHT TIME

The WEAN ENGINEERING Company, Inc.

WARREN, OHIO





To better serve the requirements of the trade and to operate at a profit in a highly competitive field, steel plant executives recognize they must have the most modern and efficient equipment available.

The Wean Engineering Company, Inc., Warren, Ohio, is the recognized leader in the design and installation of sheet, tin and strip mill equipment, whether it be one piece or a complete unit.

Many steel mill executives, both in this country and abroad, have recognized the advantages and efficiency of WEAN SHEET, STRIP AND TIN MILL EQUIPMENT. The same recognized advantages are available for overcoming your problems.

SPECIALISTS IN SHEET, STRIP AND TIN MILL EQUIPMENT

T. J. ESS, *Editor*
I. E. MADSEN, *Associate Editor*
ALBERT W. ERICKSON, JR., *Production Manager*

Board of Directors

PRESIDENT
A. J. FISHER
Assistant Chief Engineer of Construction
Bethlehem Steel Company
Bethlehem, Pennsylvania

1ST VICE PRESIDENT, C. H. WILLIAMS, *Chief Engineer,* Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania.

2ND VICE PRESIDENT, A. S. GLOSSBRENNER, *Assistant Vice President of Operations,* Youngstown District, Youngstown Sheet and Tube Company, Youngstown, Ohio.

TREASURER, JOHN F. BLACK, *General Superintendent,* Colorado Fuel and Iron Corporation, Wickwire-Spencer Steel Division, Buffalo, New York.

SECRETARY, I. N. TULL, *Electrical Superintendent,* Republic Steel Corporation, Cleveland, Ohio.

PAST PRESIDENTS: FREEMAN H. DYKE, *Assistant General Manager,* Wheeling Steel Corporation, Steubenville, Ohio.

J. L. MILLER, *Assistant Chief Combustion Engineer,* Republic Steel Corporation, Cleveland, Ohio.

HONORARY DIRECTORS: JAMES FARRINGTON, *Electrical Superintendent,* Wheeling Steel Corporation, Steubenville, Ohio.

WALTER H. BURR, *Electrical Superintendent,* Lukens Steel Company, Coatesville, Pennsylvania.

CHARLES L. McGRANAHAN, *Assistant General Superintendent,* Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania.

DIRECTOR AT LARGE, J. L. YOUNG, *Vice President of Engineering,* National Tube Company, Pittsburgh, Pennsylvania

DIRECTORS: WALTER NIELSEN, *Superintendent Blast Furnace,* Sloss-Sheffield Steel and Iron Corporation, Birmingham, Alabama.

R. W. GRAHAM, *Electrical Superintendent,* Bethlehem Steel Company, Lackawanna, New York.

W. J. TUNNY, *Assistant Electrical Engineer,* Youngstown Sheet and Tube Company, East Chicago, Indiana

E. C. McDONALD, *Combustion Engineer,* Republic Steel Corporation, Cleveland, Ohio.

J. A. SHIMMIN, *Superintendent of Maintenance,* Rotary Electric Steel Company, Detroit, Michigan.

C. R. HAND, *Assistant Superintendent of Mechanical Department,* Bethlehem Steel Company, Sparrows Point, Maryland.

ERIC L. ANDERSON, *Electrical Superintendent,* Bethlehem Steel Company, Johnstown, Pennsylvania

M. B. ANTRIM, *Electrical Engineer,* Lukens Steel Company, Coatesville, Pennsylvania.

R. E. BOBBITT, JR., *Chief Engineer,* Atlantic Steel Company, Atlanta, Georgia.

C. W. BRUCE, *Assistant Chief Engineer,* Republic Steel Corporation, Chicago, Illinois.

J. H. VOHR, *Assistant General Superintendent,* Carnegie-Illinois Steel Corporation, Chicago, Illinois.

D. N. EVANS, *Assistant Master Mechanic,* Inland Steel Company, East Chicago, Indiana.

ANDERS G. ERICSON, *Chief Engineer,* Homestead Works, Carnegie-Illinois Steel Corporation, Munhall, Pennsylvania.

Managing Director
T. J. ESS
Empire Building
Pittsburgh, Pennsylvania

Iron AND Steel ENGINEER

APRIL, 1948 VOLUME XXV NUMBER IV

In This Issue

Oxygen in the Steel Industry — by H. W. McQuaid, Consultant, Cleveland, Ohio and F. E. Pavlis, Technical Director, Air Products, Inc., Allentown, Pennsylvania 41

The Duplex Process — by D. T. Rogers, Assistant Director of Technology, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania 49

Recent Developments in Refractories — by H. M. Kraner, Engineer of Research, Bethlehem Steel Company, Bethlehem, Pennsylvania 59

AISE Annual Spring Conference Program 65

Abstracts of Papers to be presented at Annual Spring Conference .. 69

Factors in the Operation of a Mannesmann Piercing Mill — by H. R. McLaren, Assistant General Superintendent, Steel and Tube Division, The Timken Roller Bearing Company, Canton, Ohio 73

Fibrous Glass — Electrical Insulating Materials — by Harry O. Collis, Electrical Engineer, Owens-Corning Fiberglas Corporation, Toledo, Ohio 82

Job Engineering — by Robert S. Dunham, Salaried Personnel Manager, Ford Motor Company, Dearborn, Michigan 89

Design Trends in Modern Marine Power Plants — by F. V. Smith, General Electric Company, Schenectady, New York 92

Coke Oven Machinery — by Ragnar Berg, Chief Engineer, Engineering and Construction, Koppers Company, Inc., Pittsburgh, Pennsylvania 98

Design and Performance of a Refractory Recuperator — by E. G. Smith, Amsler-Morton Corporation, Pittsburgh, Pennsylvania 106

National Tube Builds New Coke Plant at Lorain 113

News Supplement 123

Dateline Diary 147

Personnel 151

Index to Advertisers 193

Published Monthly by
ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 EMPIRE BUILDING
PITTSBURGH 22, PENNSYLVANIA

Statements and opinions given in articles and papers appearing in "Iron and Steel Engineer" are the expression of contributors, for which the Association of Iron and Steel Engineers assumes no responsibility. Copyright, 1948, The Association of Iron and Steel Engineers

Single Copy Foreign Prepaid $2.00 Single Copy $1.50
Subscription price in U. S. ..... $ 7.50 per year
Subscription price in Canada (U. S. funds) ..... $ 8.25 per year
Subscription price in foreign countries ..... $10.00 per year

PLASTIC BINDING U. S. PATENT NO. 1870295 LICENSE NO. 13

3 profitable methods

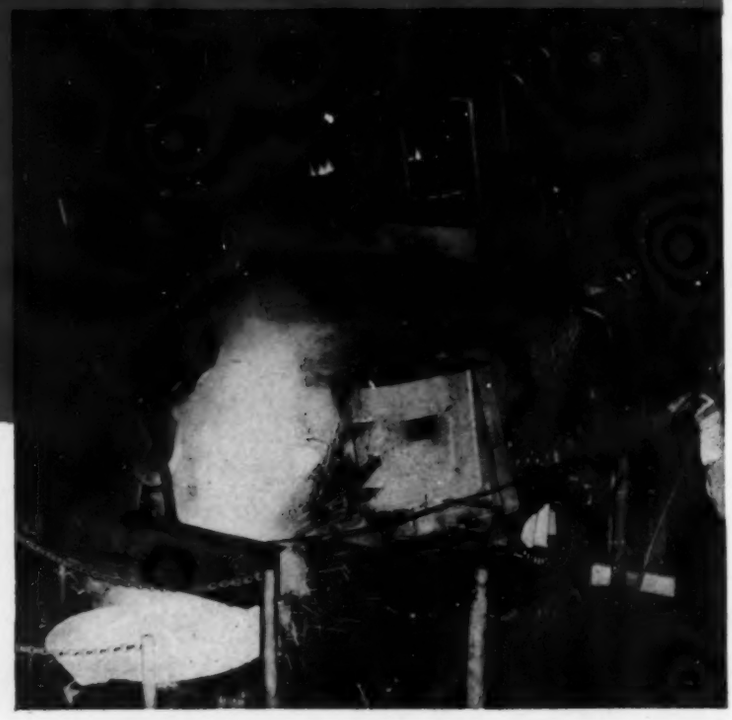
OF GRAY IRON PRODUCTION

with

MOORE RAPID

Lectromelt

FURNACES



●You can produce stronger, denser, cleaner and more readily machineable gray irons three ways when you're using Lectromelt furnaces.

1. *Batch Method*—cold scrap, melted, superheated, adjusted analytically and poured.

2. *Continuous Cold Melting*—a large molten bath, built up with off-peak power, is constantly maintained throughout the day. This is tapped periodically with a similar portion of scrap being added to replace the tapped metal.

3. *Duplexing*—molten metal is introduced to the Lectromelt furnace for superheating and analysis adjustment. Either the Batch or Continuous method can be used. A newly developed fore-hearth type of furnace is available for duplexing.

Whatever method you use, you'll get a gray iron of fine grained structure with small, evenly distributed graphite flakes—and you'll get it quickly and economically. Write for full details.

MANUFACTURED IN

ENGLAND	Birlec, Ltd., Birmingham
FRANCE	Stein et Roubaix, Paris
SPAIN	General Electrica Espanola, Bilbao
BELGIUM	S. A. Belge Stein et Roubaix, Bressoux-Liege

PITTSBURGH LECTROMELT FURNACE CORP.

PITTSBURGH 30, PA.

Oxygen in the Steel Industry

. . . . the use of oxygen in the steel industry will be influenced by the use of oxygen generators at the site, capable of producing required quantities at low cost . . . .

By H. W. McQUAID, Consultant
Cleveland, Ohio
and
F. E. PAVLIS, Technical Director
Air Products, Inc.
Allentown, Pennsylvania

▲ NO better indication of the present thinking in the steel industry as it concerns oxygen can be given than to quote from an editorial in the December, 1947 issue of the *Iron and Steel Engineer*, the official publication of the Association of Iron and Steel Engineers. This editorial states:

"Practically every major steel producer is experimenting with the use of oxygen in the open hearth, either using it to enrich the air used for combustion in the furnace, or bubbling it into the bath. Both methods have resulted in material savings in time, the first method being particularly effective during the meltdown, and the second method speeding up the working of the heat. Gains of as much as 50 per cent or more in production rate have been reported."

In addition to the open hearth application, work is being done with oxygen as a means of increasing the production from the blast furnace. The success of blast enrichment on German and Russian blast furnaces has developed intense interest in this use here and if the operations at Johnstown and Weirton check with the European results, then an immediate market will be opened up for oxygen producing units of the larger sizes providing oxygen of 80 per cent purity or higher at a producing cost of less than $10.00 per ton.

On a much smaller scale but of an equally interesting nature is the use of oxygen in making electric furnace steel especially the stainless grade.

Some discussion is taking place concerning the use of oxygen for blast enrichment in the bessemer process where a large use seems probable. The value of the oxygen addition is in the increased production obtained by using an increased temperature to permit large steel scrap additions.

A brief summary of the possible use of oxygen in the steel industry is given in Table I.

TABLE I

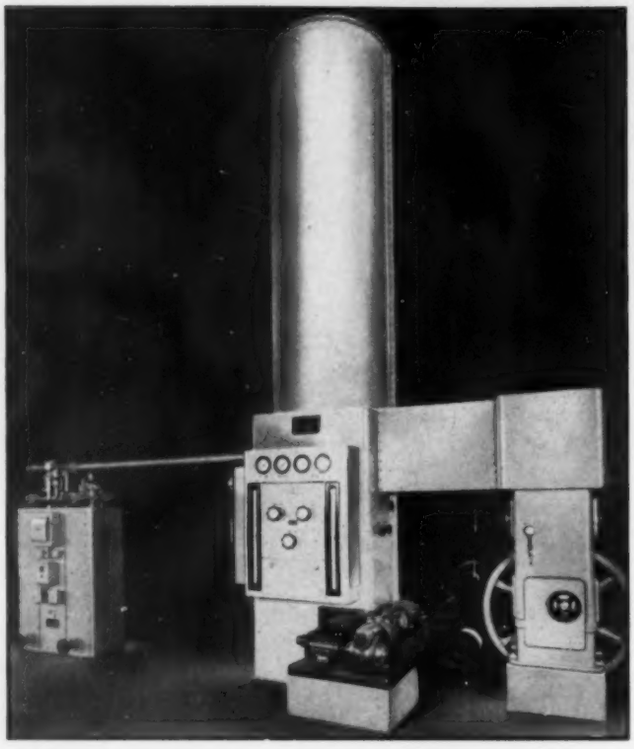
Blast furnace	300,000,000 Cu ft per day
Bessemer	8,000,000 Cu ft per day
Open hearth	170,000,000 Cu ft per day
Electric furnace	14,000,000 Cu ft per day
Scarfing, cutting, etc.	20,000,000 Cu ft per day

At the present time the important use of oxygen in steel production is for scarfing, cutting, welding and hard facing, and to some extent for carbon reduction in the open hearth and the electric furnace. There then remains the potential daily requirement of this industry for perhaps 20,000 tons of oxygen capacity, none of which is at present installed. The industry is in a most receptive mood, the opportunity is unparalleled in the history of oxygen making. The most important single factor in meeting the need is that of readily available oxygen producing equipment which will meet the economic requirements of a low investment cost and an attractive production cost.

Oxygen is produced from the air by a process of liquefaction and distillation. A number of different cycles are employed depending on the desired efficiency, purity of product, ease of operation and maintenance, compactness, and initial equipment cost. The science of air separation is not new but the methods that are employed are always changing and improving.

The recent literature on air separation has furnished much information to oxygen consumers. A certain amount of confusion has resulted, however, due to the emphasis on cost as compared to all of the other factors

Presented before AISE Annual Convention, Pittsburgh, Pennsylvania, September 23, 1947



The capacity of this oxygen generator is about 2.1 tons per day.

that must define the usage of oxygen. It is true that several tonnage-type oxygen generators are being built in this country that should produce oxygen at a cost of $10 per ton and less, but the conditions are closely defined. Certain consumers, however, cannot use tremendous quantities of lower-purity oxygen even if it can be produced at low cost. The growing promise of oxygen must be as interesting to the small consumer as to the large one. Oxygen can be generated for consumption at a low cost when:

1. Power and cooling water are available and inexpensive.
2. Very large quantities of oxygen are produced continuously at a relatively constant rate.
3. High purity is not required.
4. High compression of the oxygen is unnecessary.
5. A high degree of dryness is unnecessary.
6. The oxygen is generated adjacent to its place of consumption so distribution can be made by pipe line.
7. The depreciation and interest charge on the capital cost are low.
8. Standard models are built.

It is obvious that the tonnage-type of oxygen generator is built for the special purpose of large production at low cost and that other types of smaller generators must be provided for all those other conditions for which the large tonnage generator is unsuited. Fortunately, these smaller generators are already developed and in service throughout the country. They produce high-purity oxygen and compress it to any pressure desired; they are compact, reliable, easy to operate and maintain, and are adaptable to intermittent operation. Frequently, storage systems are associated with the generators so widely varying consumption rates may be possible even though the production rate is less variable. As with most generators, the pure oxygen generators increase in efficiency with size.

Tables II and III give typical operating data for some of the oxygen generators manufactured by our company. The generators in Table II are low-capacity, compact units especially suitable for the small consumer and for intermittent operation. The generators in Table

TABLE II

Typical Operating Data, Oxygen Generators

	Model R-750	Model R-1250
Production at 20 C (68 F) and 14.4 psi	750 cu ft per hour of gaseous oxygen or 40 lb per hour of liquid oxygen	1250 cu ft per hour of gaseous oxygen or 50 lb per hour of liquid oxygen
Oxygen purity	99.5 per cent and higher	99.5 per cent and higher
Dew-point temperature of oxygen	—180 C (—292 F)	—180 C (—292 F)
Oxygen charging pressure	0 to 2300 psi	0 to 2300 psi
Dry-nitrogen production	4000 cu ft per hour at purity of over 91 per cent*	5500 cu ft per hour at purity of over 94 per cent*
Starting time from defrost at 20 C (68 F)	3 to 4 hours	3 to 4 hours
Starting time after 8-hour shutdown, at 20 C (68 F)	1 to 2 hours	1 to 2 hours
Time required to defrost generator	1 to 2 hours	1 to 2 hours
Average electric-energy consumption for producing and compressing oxygen to 2300 psi	5.5 kwhr per 100 cu ft of oxygen	4.5 kwhr per 100 cu ft of oxygen
Cooling-water rate, with water at 20 C (68 F)	9 gallons per minute	13 gallons per minute
Labor requirement: average time, one operator	15 minutes per hour	15 minutes per hour

*With alterations, these models will produce: 200 to 500 cu ft per hour of dry nitrogen gas, or the equivalent in liquid nitrogen, at a purity of over 99 per cent; or over 500 cu ft per hour of dry nitrogen gas, or the equivalent in liquid nitrogen, at a purity of over 98 per cent. The oxygen production rate is reduced about 10 per cent when the generator is operated to produce nitrogen at these purities.

III are high-capacity, more efficient units for the large consumer. Multiple installations of both types are very popular.

These generators are built to be operated by the oxygen user on his premises in accordance with his oxygen requirements and at substantial savings over commercially procurable oxygen in like quantities. The main reason this is possible is through the elimination of the cost of distribution. Both lower-purity, tonnage-type generators and high-purity generators should be operated at the place of consumption and in conjunction with a pipe-line distribution system for low unit cost of oxygen.

To date, almost all of the experiments that the steel companies have conducted on the various uses of oxygen were done with high-purity oxygen. Substantial savings were noted in most cases and other advantages were indicated. The small consumer of oxygen will use his high-purity generators for all established and newly developed uses. The large consumer will use high-purity generators for those requirements where high-purities are required, and the lower-purity tonnage-type generator where extremely low cost is necessary. Both will benefit by generating their own oxygen in accordance with their needs and with pipe-line distribution means.

Since the basic raw material, air, is available at no cost and the only other materials necessary for pure-oxygen production are relatively unimportant amounts of caustic soda and lubricants, it becomes apparent that the major items of direct operating cost are the power required, and the supervisory labor. The additional labor required is small indeed where these units can be installed in a powerhouse or air compressor station.

Pure-oxygen generators are installed by us on a lease basis and consequently the decrease in the direct cost of oxygen produced by them is even more interesting to the consumer, since little if any capital investment is required. Their selection for use in all types of operations from hospitals to large steel plant installations is an indication of reliability, ease of operation, and a reduction in the cost of the oxygen produced and compressed. It is increasingly evident that with consumer operation of these simple and reliable oxygen generators, the cost of oxygen for conditioning, scrap preparation and maintenance is very materially reduced as compared to its production and conveyance for any distance, either as a compressed gas or as a liquid from a central producing plant.

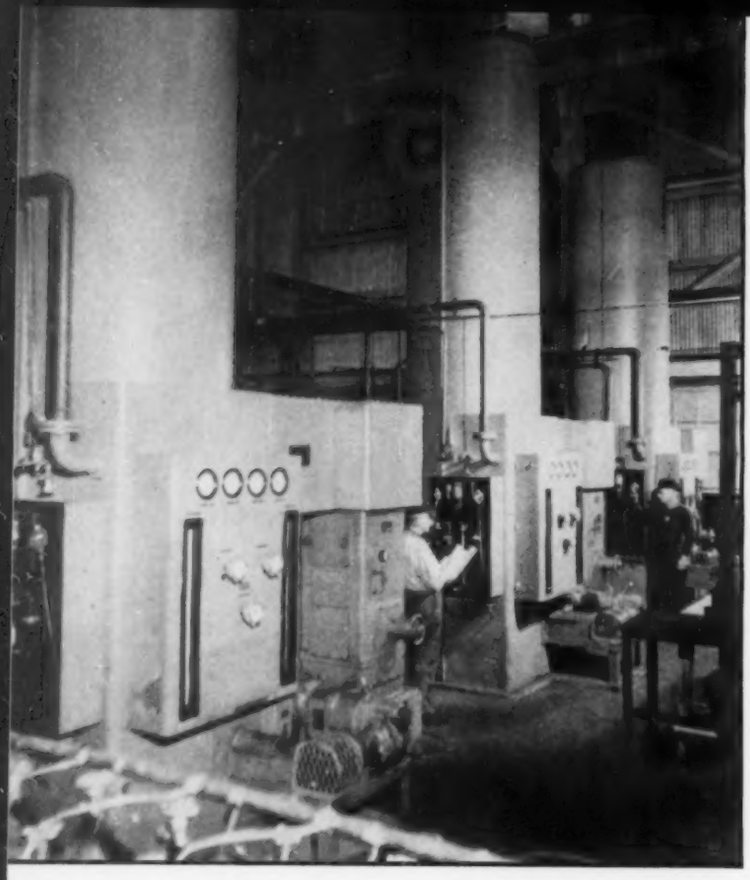
Since these standard pure-oxygen generators are available in unit capacities from three-quarters of a ton per day (about 750 cu ft per hour) to ten tons per day (about 10,000 cu ft per hour), any plant that desires, can, by a suitable combination of units, provide for practically any oxygen requirements for scrap preparation, conditioning, and maintenance. These units are designed so that they can be shut down and started up with only a few hours delay and since full capacity operation is the most economical, they are provided in multiple units and with storage facilities that permit the most satisfactory operation. The oxygen can be also compressed into standard cylinders or at standard pipe line pressure for direct distribution. Approximately

TABLE III

Typical Operating Data, Oxygen Generators

	Model E-2000	Model E-5000
Production at 20 C (68 F) and 14.4 psi	2100 cu ft per hour of gaseous oxygen or 50 lb per hour of liquid oxygen	5000 cu ft per hour of gaseous oxygen or 75 lb per hour of liquid oxygen
Oxygen purity	99.5 per cent and higher	99.5 per cent and higher
Dew-point temperature of oxygen	—180 C (—292 F)	—180 C (—292 F)
Oxygen charging pressure	0 to 2300 psi	0 to 2300 psi
Dry-nitrogen production	8000 cu ft per hour of gaseous nitrogen at purity of over 97 per cent*	15,000 cu ft per hour of gaseous nitrogen or 75 lb per hour of liquid nitrogen at purity of about 99 per cent
Argon production (with auxiliary equipment)	60 cu ft per hour at purity of over 80 per cent	120 cu ft per hour at purity of over 80 per cent
Starting time from defrost at 20 C (68 F)	6 to 8 hours	6 to 8 hours
Starting time after 8-hour shutdown, at 20 C (68 F)	3 to 4 hours	3 to 4 hours
Time required to defrost generator	1 to 2 hours	2 to 3 hours
Average electric-energy consumption for producing and compressing oxygen to 2300 psi	3.5 kwhr per 100 cu ft of oxygen	3.2 kwhr per 100 cu ft of oxygen
Cooling-water rate, with water at 20 C (68 F)	17 gallons per minute	35 gallons per minute
Labor requirement: average time, one operator	20 minutes per hour	30 minutes per hour

*With alterations, this model will produce: about 400 cu ft per hour of dry nitrogen gas, or the equivalent in liquid nitrogen, at a purity of over 99 per cent simultaneously with the full rated production of oxygen at 99.5 per cent purity; or about 8000 cu ft per hour of dry nitrogen at a purity of over 99 per cent simultaneously with the full rated production of oxygen at 98 per cent purity.



This layout in a large steel plant consists of four 2100 cu ft per hour high purity oxygen generators.

four times as much nitrogen is produced as oxygen. This is usually wasted but can be made available for furnace atmosphere control if desired.

The use of oxygen in steel plants can be divided into three fields as follows:

1. Cutting, scarfing and welding.
2. Blast enrichment.
3. Carbon reduction.

The use of oxygen for scarfing, and hard facing has shown a healthy increase each year. This is largely due to the acceptance of automatic and hand scarfing to replace the chipping chisel. The principal factor in this use of oxygen was the high cost of labor of the chipping crews. The use of oxygen in cutting, scarfing, welding and hard facing promises to grow at a very healthy pace, and is largely predicated on the cost of oxygen. Every steel mill is to some degree interested in this problem, but none more interested than the smaller plant making special grades. All the oxygen used in scarfing and cutting is 99.5 per cent pure. The large steel foundries offer an important field where a large potential market exists for such oxygen at low cost for cleaning up castings and cutting up scrap.

Burner blast enrichment is frequently considered in three divisions:

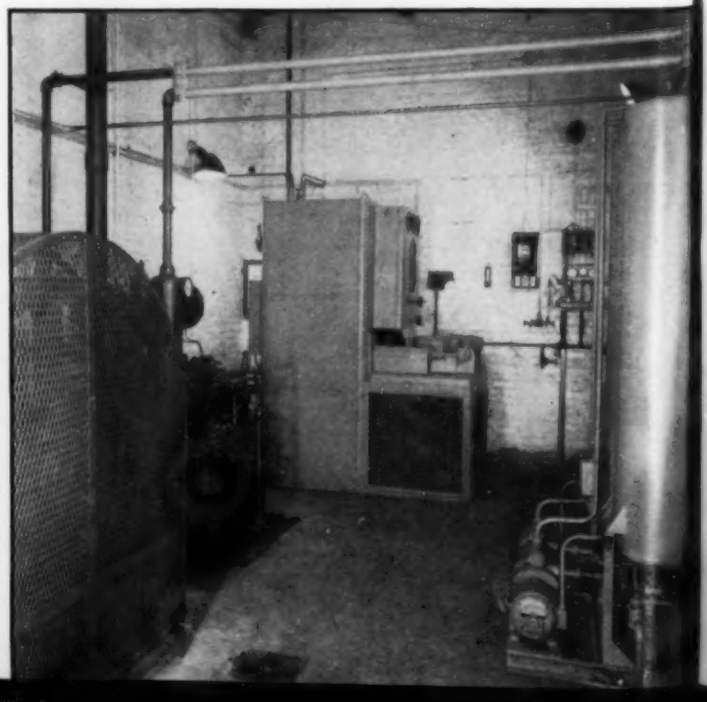
1. Blast furnace and cupola.
2. Large open hearth plants.
3. Small open hearth plants.

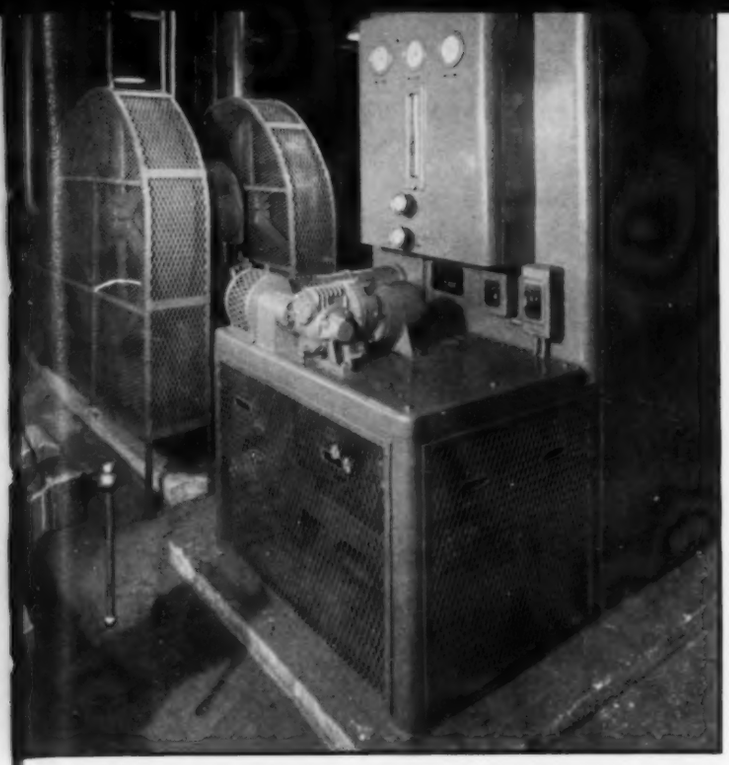
These are all very large tonnage (of oxygen) application with the exception of the cupola and the small open hearth. The cupola field has not been thoroughly studied by the writers, but the present economics of good cupola operation make it seem rather attractive. The use of oxygen for blast enrichment in the blast furnace has been studied in Germany and Russia, and will be tried here on a rather large scale. The European tests seem quite conclusive in showing the possibilities for increasing blast furnace production with an increase of approximately 25 per cent in the oxygen going into the furnace with no corresponding increase in nitrogen. This increase represents approximately 3300 cu ft of oxygen added per ton of iron made. An increase in production of approximately 30 per cent and a coke decrease of about 150 lb per ton is claimed. For a large (1200 ton) furnace this would mean an oxygen plant which could supply approximately 170 tons of 90 per cent oxygen per day.

For blast enrichment on the large open hearth, the indicated requirement of oxygen is more than 600 cu ft per ton or approximately 16 tons per furnace per day (200 ton furnace). For a ten-furnace plant of this size furnace, the oxygen requirement would be close to 160 tons a day of low-cost oxygen for blast enrichment alone. Such projects as these are being discussed and in several cases are actually being developed. If these are successful, then, as is usual in the steel industry, there will be a rush to get into the parade and the demand for exceedingly large tonnage oxygen plants will increase at a remarkable rate. This development of course depends entirely on the cost of oxygen and requires, according to some, oxygen at less than $10.00 per ton for 90 per cent oxygen in amounts from 100 to 200 tons per day.

The small open hearth in the higher cost fuel regions, using fuel oil such as in Canada, offers what appears to be a possible field for the high-purity higher-cost oxygen. Using approximately 800 cu ft of oxygen per ton (as at Steel Company of Canada) there is a possibility of increasing the tons per hour by about 33 per cent. This as nearly as can be estimated would be a saving of about $1.00 per ton in addition to the extra sales profit on a larger furnace production. In a smaller or less modern installation, this saving might be increased to $1.50 or $1.75 per ton in decreased operating cost above

This 750 cu ft per hour high purity oxygen generator is located in a steel foundry.





This view of a 750 cu ft per hour high purity oxygen generator shows the liquid oxygen pump for developing high oxygen pressure.

materials. At an oxygen requirement of 800 cu ft per ton, this would mean that oxygen would have to be available at approximately $1.70 per thousand cubic feet to break even on a small open hearth and at approximately $1.00 per thousand cubic feet to break even on a large modern open hearth. These estimates do not include any allowance for higher refractory costs or other incidental costs.

The standard generators previously described will produce high-purity oxygen at a cost which might make blast enrichment attractive to the small open hearth operator and at the same time make its use especially valuable in the cutting, scarfing and welding operations in the same plants.

The use of oxygen to enrich the air blast for combustion type burners is old in principle and relatively simple in operation. It can be criticised in operation because it is, under some conditions, extremely hard on refractories and inefficient to a degree depending on the general furnace efficiency.

The use of oxygen to actually supply heat by direct oxidation of the hot scrap is in some ways much more attractive. It involves heating the scrap in the usual way to its ignition temperature, and contacting the heated scrap with high-purity oxygen thereby causing the scrap to burn the same as any other fuel. The heat is developed at the point where it is the most efficient, and the oxidized products formed are of direct value in starting the initial oxidizing reactions with silicon, phosphorous, and carbon. The burning of steel scrap as a fuel will produce far more heat units per pound of oxygen required for combustion than would be obtained with carbonaceous fuels. If the amount of oxygen for this purpose is limited to that necessary for providing only the iron oxide which can be utilized in the given heat, then all the iron used for fuel will be finally returned to the bath to reduce the cost of the whole operation. Thus an amount of oxygen which is dependent on the composition of the charge and the type of steel being made, can be used to advantage in burning scrap. The high iron charges which need iron oxide in their working would use the most oxygen in burning scrap whereas the all-scrap, high-carbon, electric furnace heat would use the least.

Even in the electric furnace some oxygen can be used to advantage in cleaning the banks, and in speeding up melting on almost any heat. The saving in power will usually more than pay for the cost of the high-purity oxygen. It is necessary to use good judgment and some skill in burning scrap in the furnace as fuel.

The scrap must be above the ignition point in temperature and the concentration of oxygen at the point of application must be close to 100 per cent pure. The dilution of oxygen at the point of application with only a small percentage of air will reduce greatly the speed of the reaction and oxygen will be wasted. If the temperature is much below 2250 F, the reaction will also slow up and much oxygen will be wasted.

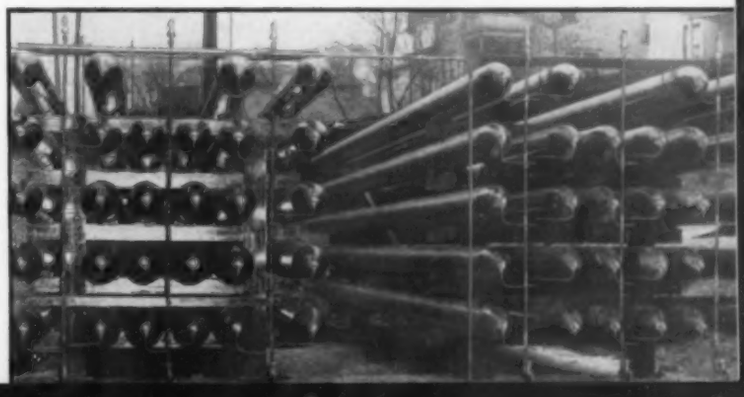
With light scrap and much recharging, the oxygen lance is best used in between cuts of charging buggies so that more room will be made in shorter time for the next charge. The lance used is usually a length of one inch or smaller standard pipe with oxygen at line (150 psi) pressure. The lance is carefully used to concentrate high-purity oxygen at points where the scrap is at a good white heat and is moved as the melting of the scrap by it proceeds. The main objective is to keep the scrap burning and melting with the minimum waste of oxygen and burning of the pipe, and to a degree this is governed by the charge composition or the desired iron oxide in the bath at meltdown. High iron oxide in the bath while melting down is an aid in silicon and phosphorous removal which results in a quicker and more active starting of the carbon drop.

The use of oxygen for a short time in the bath to help get the lime up is also beneficial. The whole bath increases in temperature and the lime boil starts uniformly and much time can be saved. Usually compressed air will work just about as well as oxygen for this purpose especially when the carbon is above 0.50 per cent.

The use of oxygen is also of value in speeding up the reaction of an ore addition probably by improving the bath agitation and reducing the time necessary to bring the ore to the bath temperature.

It is interesting that in practically every case where the carbon is above about 0.50 per cent that compressed air properly applied will come close to duplicating the action of oxygen. This has been demonstrated many

Large special cylinders are used in this 200,000 cu ft oxygen storage system.



Standard cylinders are used in a 15,000 cu ft oxygen storage system.

times in the open hearth and electric furnace and, of course, is demonstrated every day in the side and bottom-blow bessemer furnace.

Air is somewhat slower than oxygen as would be expected, but its easy availability and low cost make it of interest. In considering oxygen for the large tonnage steel plant, the cost of the air eliminated should be credited to the oxygen cost. For reducing carbon, it has been the experience of some that oxygen is best for the low carbon ranges, but that air is more economical in the higher carbon ranges. Thus where higher iron charges are possible, the air is very satisfactory for reducing carbon from as high as 3 down to 0.50 per cent. The rate of carbon drop can be controlled and varied according to conditions from 0.60 per cent carbon per minute to 0.02 per cent carbon per minute.

The lower rate is obtained by the use of relatively low pressure air (about 2 psi at the orifice) introduced through a simple two step pipe. The pipe size is governed by the volume required but one length of two inch pipe fed through a short piece of one inch pipe will reduce a 90 psi line pressure to approximately two pounds velocity pressure at the outlet. The low pressure is necessary to avoid extreme agitation of the bath where the pipe is inserted. Too much boiling at the surface will cause slag and iron oxide to be spattered on the side walls and roof with very adverse effects on their performance.

It is believed that combinations of oxygen and air will be used eventually for carbon reduction, with 100 per cent air being used in the high carbon ranges and 100 per cent oxygen in the lower carbon ranges. This will facilitate the use of higher iron charges in the open hearth and electric furnace as well as the making of very low carbon grades. By speeding up the ore and lime boils, and getting the temperature and action up on cold heats, and by helping a poor slag to shape up it will be found that oxygen (and air) will become a very valuable tool, in connection with the melting furnace. By reducing to a few minutes the time required to reduce high-carbon meltdowns, we have a means for increasing high iron and hot metal charges in the electric furnace as well as the open hearth. This promises to change the economics of the electric furnace in the future.

Thus, oxygen for reducing carbon is easy to use and even at the high price of cylinder oxygen has been found to be economically of advantage especially in making low carbon stainless steel grades. With the installation of generating equipment, the use of lower-cost oxygen is highly interesting for nearly every application to carbon reduction and bath conditioning.

One of the criticisms in some shops to the use of oxygen (and air) is the high cost of the pipe used to introduce it into the bath. While many different types of nozzles or tuyeres have been tried covering various grades of refractories and many designs, a well slagged pipe remains the simplest and easiest to handle on the floor. The life of the pipe is governed by the velocity of oxygen or air passing through it, by the temperature of the bath, and by the slag condition. Since the velocity in most cases is limited to prevent splashing of slag and steel on the refractories, and the temperature of the bath and type of slag are governed by the furnace, there is little that can be done to increase the life of the pipe used except by developing a special coating. Much work is being done with this objective. High temperature baths and high lime slags are hard on the pipe used for introducing oxygen or air so that the life of the pipe in a high-carbon, open hearth melt-down bath is far better than in a low-carbon, electric-furnace bath.

In conclusion, it may be repeated that the cost of oxygen has been (greatly) reduced by developments in oxygen generators. These have increased the availability and improved the economics of the use of oxygen throughout the steel industry. The use of these generators permits a much wider and more economical use of oxygen for conditioning, scrap preparation and maintenance as well as a more wide spread use for speeding up melting, carbon reduction, and bath conditioning in the open hearth and electric furnace. In the largest units the reduction in cost is sufficient to make its economical use possible for the large open hearth and blast furnace blast enrichment.

DISCUSSION

PRESENTED BY

F. C. KERRY, Canadian Liquid Air Company 1111 Beaver Hall Hill, Montreal 1, Canada

JAMES F. POLLACK, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania

MARTIN J. CONWAY, Steel Industry Consultant, Stacey-Dresser Engineering Company, Gap, Pennsylvania

H. W. McQUAID, Consultant, Cleveland, Ohio

F. E. PAVLIS, Technical Director, Air Products, Inc., Allentown, Pennsylvania

F. C. Kerry: There seems to be a little confusion as to the problem of producing tonnage or cheap oxygen. The production of tonnage oxygen is not new. Tonnage

plants have been in existence for a long time. They have had these plants in Europe, particularly Germany; there are two in France, in fact, one has been operating for twelve years; and one is being built in Holland and will be operating in two or three months. Making cheap oxygen is not a problem at all. The big problem today is to integrate the factors or the conditions of the user with those of the producer. There is a critical minimum of production, which seems to be around sixty tons a day; below this figure it is questionable whether oxygen from tonnage plants can be produced cheaply enough. Above that figure, you cannot compete with the low price for tonnage oxygen.

There is another problem and I refer to the question of bubbling oxygen into the bath, that is, the question of whether you should use air, nitrogen or oxygen. I think this problem is more of academic than practical interest. Oxygen is definitely more valuable.

We all know that all you have to do to get efficient and fast refining is to mix the slag and the metal as intimately as possible. In fact, some years ago a Frenchman came out with the idea of producing artificial slag in one ladle and hot metal in another and mixing the two together. If you use enough air or nitrogen, you can get a vigorous action in the bath and obtain good refining. Your action has to be so vigorous, however, that you cannot avoid obtaining these tremendous bubbles and splashing described in the previous papers.

The process of bubbling oxygen into the bath is not one for obtaining vigorous bubbling of the bath, though it helps, but for obtaining a direct reaction of oxidation.

We have run hundreds and hundreds of heats on carbon reduction with oxygen alone and, if you use a small lance or several small lances to get your necessary volume of oxygen, you will obtain only a gentle bubbling action with no splashing. With this method, oxygen is introduced in a thin, narrow stream just in the interface between slag and metal and is diffused throughout. We have never had any trouble whatsoever with furnace roofs, walls or anything of that kind.

James F. Pollack: Of particular interest to an open hearth operator, of course, is the possibility of realizing increased output with existing facilities. We at Jones and Laughlin, as well as a majority of the open hearth operators in the steel industry, have experimented with the use of oxygen as an aid to combustion and also as a bath addition to speed up the reduction of carbon content.

Due to our setup at Pittsburgh works, where we use high scrap charges and are short of iron, the possibility of a faster meltdown of our scrap charges for the scrap-hot metal heats with the use of oxygen was particularly attractive. During the course of our tests, various different types of burners were tried, all of which produced flames resulting in faster meltdown. However, there was considerable difference in the various types of burners from the standpoint of maintenance.

Our tests using oxygen supplemented burners have shown that the use of oxygen results in increased tons-per-hour and decreased fuel consumption on individual heats. However, the averages over a campaign, including delays and rebuild, do not indicate a gain in yearly tonnage. If we are to realize the full benefit from the use of oxygen, our experience to date indicates:

1. Improvements are necessary in present stockyard facilities to obtain consistently faster scrap charging time. If this cannot be done, oxygen supplied to the burner is being wasted.
2. There is a need for improved roof refractories to withstand the effect of higher flame temperatures and the erosive effect of a larger volume of combustion products.

We have used both oxygen of high purity and compressed air to reduce bath carbon content. Oxygen was introduced to the bath through water cooled jets and also through unprotected 1 in. pipes. During the course of our tests, preference was shown for the use of the pipe as it was the simplest and easiest to handle on the open hearth floor. With the experience gained by handling the pipe, and a simple method of holding the pipe firmly in the wicket hole opening, the life of the pipe was increased from a few minutes to approximately 45 minutes.

The use of both high purity oxygen and compressed air as a bath addition speeded up carbon elimination. In the higher carbon ranges, the results obtained with the use of oxygen and compressed air are comparable. However, in the lower carbon ranges, under 0.20 per cent carbon, oxygen is definitely superior. In our tests, the addition of oxygen to the open hearth bath resulted in an increase in bath temperature, but when compressed air was used, the bath temperature dropped. The moisture content of the compressed air which we used was responsible for the temperature drop. As in the case of the oxygen supplemented burner, the use of the bath injection practice has these drawbacks:

1. Excessive splashing has proven detrimental to the life of the silica brick roof.
2. The fumes ejected are excessive. This is a problem in large cities where dirt ordinances are in effect or being contemplated.

While results to date throughout the industry indicate open hearth operators can realize increased tons-per-hour and decreased fuel consumption, there are several problems which must be solved. The problems encountered to date are not insurmountable but are of such a nature that the steel industry will proceed slowly in the complete adoption of oxygen in steelmaking.

Martin J. Conway: I sympathize with the authors in that it is difficult to discuss hard and fast rules for the application of oxygen to open hearth operations, to which their paper is chiefly directed, because, while the results thus far obtained, taken as a whole, indicate substantial advantages, the methods of appreciation and quantities used per ton of ingots produced are and will continue for some time in a state of flux. Furthermore, after some semblance of order is restored, individual shop practice will vary, as open hearth practice always has varied.

However, as indications point to the use of steel-plant operated oxygen producing units, the total oxygen consumption of the steel plant should not be overlooked in these studies, as a process is available which will produce both a small stream of 99.5 per cent purity oxygen and a major stream of low purity oxygen simultaneously. If proper credit is allowed for this stream of high purity oxygen, then the major stream of lower purity oxygen is available at a considerably reduced

cost, making the complete plant application extremely attractive.

H. W. McQuaid and **F. E. Pavlis:** In reading the preceding comments, it is evident that there is indeed an important place for oxygen in open hearth and electric furnace steelmaking. Mr. Kerry has achieved results on a commercial scale which seems to overcome some part of the difficulties indicated by Mr. Pollack in his discussion. The problem of fumes is still an important one and is especially hard to solve on high carbon heats with relatively high residual manganese when operating in a closely settled community.

The use of oxygen is indicated as a tool to aid the melter by being available when scrap is slow to melt down, when the lime boil or ore boil is slow to start, when heats under 0.10 per cent carbon are required, or when something is needed to help open a tap hole. For these uses, the time for oxygen application is short and fumes while in some cases heavy are of short duration. In the very low carbon and manganese ranges, the fumes are of much less volume and problem. If oxygen (or air) is to be used for high carbon heats in urban communities the answer is apparently the collecting and washing of the fumes.

Mr. Kerry's statement that for tonnage uses the low economical production of oxygen is sixty tons a day is without doubt correct for plants using oxygen for flame enrichment. For the purpose of producing oxygen for uses around the open hearth and steel mill where high purity oxygen is needed or an advantage such as scarfing, cutting, stimulating bath reactions and other uses, the new simplified oxygen generators developed by the war offers advantages in even the smallest of plants. These are being used in steel foundries in sizes down to less than one ton per day, and in one steel plant a production capacity of over two hundred tons per month of high purity oxygen has been running economically with the very minimum of attention for over two years.

ASSOCIATION OF IRON AND STEEL ENGINEERS

PHILADELPHIA SECTION

William N. Horko, *Chairman*

Linn O. Morrow, *Secretary*
Shaff Building
Philadelphia 2, Pennsylvania

INSPECTION TRIP

WEDNESDAY, MAY 19, 1948.

John A. Roebling's Sons Company extend an invitation to AISE members and their guests to visit their plant at Roebling, New Jersey. Roebling is twelve miles south of Trenton on New Jersey Route 25.

The inspection will start promptly at 11:00 a.m. Visitors should drive to the main gate and receive instructions for parking cars. Report to the gate house at the main gate for registration.

Luncheon will be served at the Village Tavern in Roebling, and it is necessary to make reservations. Those who intend to go should write the Philadelphia section, giving them names of all who will attend.

The Duplex Process

. . . . the duplex process will produce about two and one-half times the tonnage of the stationary furnace charging 50 per cent scrap . . . . the shorter time required is also of advantage in ultimate steel quality . . . .

By D. T. ROGERS, Assistant Director of Technology
Jones and Laughlin Steel Corporation
Pittsburgh, Pennsylvania

▲ THE word "duplex," when applied to steelmaking, has the general meaning of steel produced by the combination of two separate processes. Thus in its most complete sense, steel produced through the linking together of any two individual processes may properly be referred to as duplex steel. For the purpose of this discussion, however, the term duplex refers specifically to the acid bessemer-basic open hearth combination which is the only duplex process of commercial significance in the United States today.

The predominant tonnage of steel made in America is the product of the basic open hearth "scrap" practice. The raw materials for this practice are steel scrap and molten pig iron, charged in roughly equal amounts, the percentage governed by the relative cost and availability of each, and by the analysis of the steel being produced.

Fundamentally, the duplex practice differs from "scrap" practice only in that molten steel, or blown metal, as it is commonly referred to, is substituted in the charge for cold scrap. This blown metal from the acid bessemer converter, plus whatever pig iron is required to provide sufficient excess of carbon to enable proper refinement before tapping, constitutes the total metallic charge.

In both processes, of course, the important objectives are:

1. To eliminate certain undesirable elements from the charge through oxidation.
2. The proper addition of materials to meet the chemical specification and effect the desired degree of deoxidation.
3. The attainment of certain desirable properties in the steel apart from the chemical analysis.

It is in the amounts of various elements present in the respective charges, and the manner and rate of their elimination, that significant differences exist between the processes.

HISTORY OF DUPLEXING

The history of duplexing may be said to date from the experimental work in 1872 of F. Lang, at Neuberg, Styria.[1*] Lang experimented with a method of making steel in the acid converter and the acid open hearth, for the express purpose of accelerating the tedious process of carbon oxidation in the acid open hearth. This method never achieved a commercial acceptance, although Lang claimed savings of two hours in the time of a heat.

The development of the basic refractory for furnace linings by Thomas and Gilchrist about 1877, inevitably led to attempts to combine the advantages of the acid-basic processes. The first suggestion of this combination was made by Harmet of France, in a paper delivered before the Iron and Steel Institute in 1879.[2] British patent No. 591 was granted to Harmet in February of the same year, covering the process of duplexing in two converters, acid and basic, as well as in an acid

Presented before AISE Detroit District Section Meeting, March 11, 1947

NOTE: * See Bibliography at end of the paper.

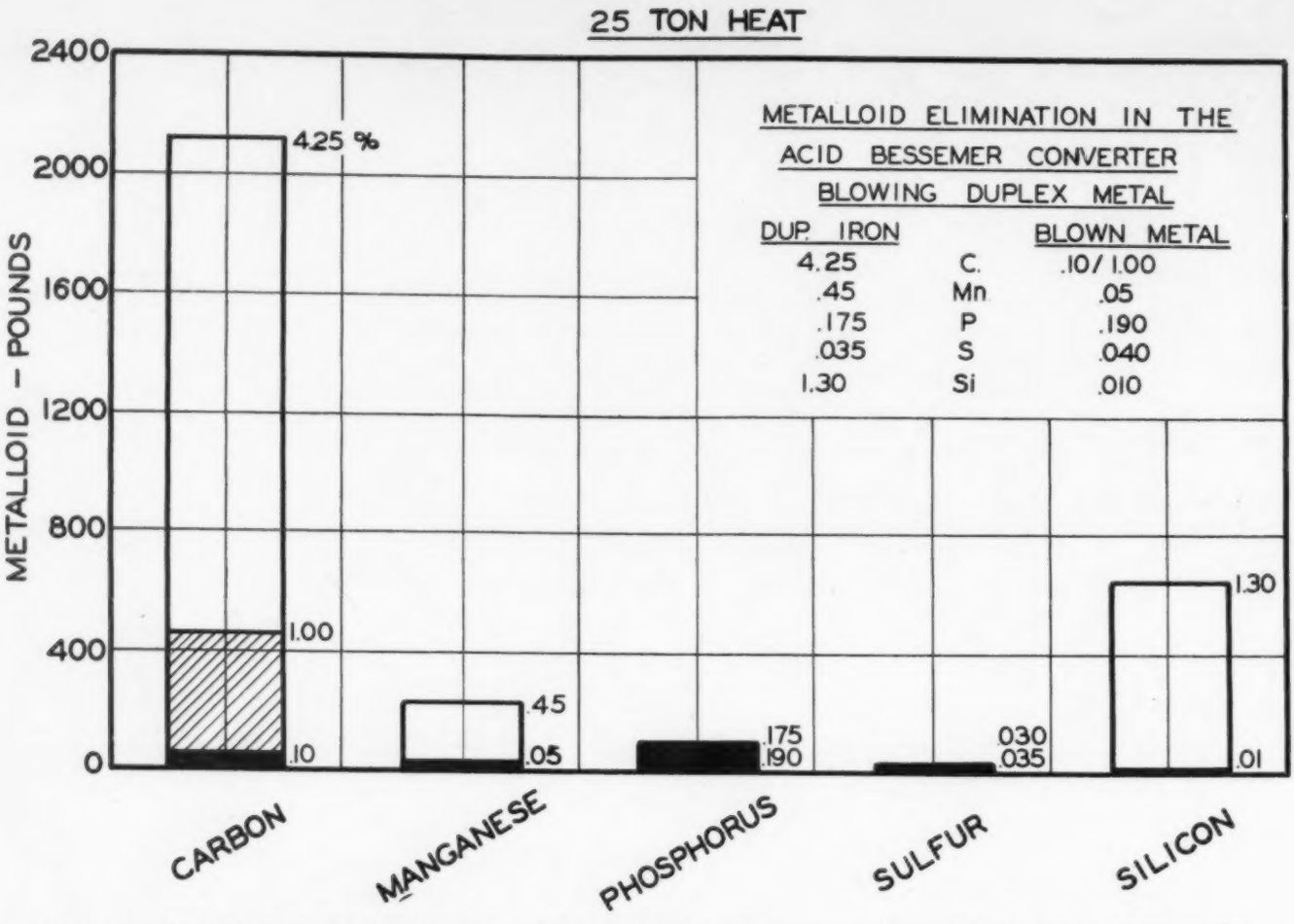


Figure 1 — Most of the carbon, silicon and manganese in the raw iron are removed from duplex blown metal in the acid bessemer process. Phosphorus and sulphur are slightly increased due to weight loss in blowing.

converter and a basic open hearth. The description of the operation in this patent would serve, with only minor changes, to describe the duplex process as carried on today. The first commercial application of Harmet's process was practiced with two converters about 1885, at Stenay, near Paris, by Walrand and Delattre.[3] Duplexing with the acid bessemer and basic open hearth had its first commercial development at Witkowitz, Austria, about the year 1890.[4]

The Witkowitz operation employed one 4-ton bessemer converter to supply blown metal to three stationary open hearths of about 20 ton capacity. The charge was limited to 60 per cent blown metal and 40 per cent cold pig iron, due to the inability of the blast furnace capacity to supply enough iron for three open hearths. The bessemer practice was simply one of desiliconizing the blast furnace iron — the carbon, manganese and phosphorus being left for the open hearth to remove. Thus, time of blows was only five to six minutes, about half the time of present day blowing practice for duplex metal.

Despite the fact that the duplex operation achieved some commercial success at Witkowitz (savings of about $2.50 per ton over regular open hearth methods were claimed) the practice did not catch on to any appreciable extent in Europe. This was probably due to a combination of economic factors, differing somewhat in the various steelmaking regions, some of which were the availability of suitable iron ores for successful operation of the basic bessemer, or the basic or acid open hearth practices, the cost and availability of heavy melting scrap, and individual plant facilities and layout.

In America, the duplex process had a more favorable reception. The first American plant to install the process was the Ensley works of the Tennessee Coal Iron and Railroad Company, in 1904.[5] In this region of Alabama, duplexing found a combination of favorable economic factors. There was, first, an abundance of cheap ore and coke at hand, thus justifying large iron-making facilities. The ores were of a quality not particularly favoring either the basic bessemer or the basic open hearth processes, since the phosphorus was rather too low for the former and somewhat high for the latter. Further, the silicon and sulphur in the ores made for a difficult problem in production of basic open hearth iron, in that operating a "hot" blast furnace to eliminate undesirable sulphur resulted in silicon of undesirable amounts for direct open hearth use. The duplex process permitted running blast furnace temperatures high for elimination of sulphur without necessity for holding to stringent silicon specifications. It is also significant that scrap was relatively scarce and expensive at Ensley, due to the isolation of the deep South from the major manufacturing districts of the nation.

The first Ensley plant consisted of one 15-ton con-

verter and eleven 50-ton open hearths, ten tilters and one stationary. In 1907, the operation was considerably expanded, and a second duplexing plant, consisting of two 20-ton converters, and two open hearth shops of four 100-ton tilting furnaces, was built. This expansion permitted duplexing for the first time on the large scale which has since marked the practice in the United States.

The invention of the tilting open hearth furnace by Campbell, the first of which was built at Steelton, Pennsylvania, in 1890, contributed significantly to the success of duplexing.[6] Following the major installation of tilting furnaces at Ensley works (these incidentally of Wellman design rather than of the Campbell design), several companies adopted the duplex process, until, during the years of the first World War, a total of six companies — the Tennessee Coal, Iron and Railroad Company, Maryland Steel Company, Bethlehem Steel Company, Colorado Fuel and Iron Corporation, Lackawanna Steel Company, and the Jones and Laughlin Steel Corporation — produced nearly 4,500,000 tons of duplex steel ingots in a single year.

In the period following the first war, virtually all large plants employed the process, but due to a combination of economic factors the number of duplexing operations has diminished until at the present time the only companies making duplex on a consistently large scale, are the Tennessee Coal, Iron and Railroad Company and the Jones and Laughlin Steel Corporation. The Carnegie-Illinois Steel Corporation maintains duplexing facilities at some of its plants, and duplexes whenever the rate of operations crowds the open hearth facilities unduly. There is also the relatively new operation practiced at the Weirton Steel Company, utilizing two 25-ton converters and twelve stationary open hearth furnaces ranging from 200 to 400-ton capacity. This operation[7] is not duplexing in the complete sense, however, since it employs a mixed charge of 70-80 per cent blown metal of about one per cent carbon, with 20-30 per cent of cold scrap and 5 per cent limestone. The blown metal is referred to as "synthetic scrap."

ECONOMICS OF DUPLEXING

The popularity of the duplex process in America may be closely related to economic conditions. Emerich and Feigenbaum[8] have effectively shown the relationship of the price of heavy melting scrap to the rate of duplex operation from 1912 through 1940. Unfortunately there have been no figures compiled by the American Iron and Steel Institute since then — therefore, no official record exists for the ingot-ton production of duplex facilities during the peak operations of the war years. It is probably safe to estimate, however, that something better than 6,000,000 tons of duplex steel has been produced each year from 1941 through 1946.

It is evident, of course, considering the relative constancy of the cost per ton of iron in both slack and peak operational periods, that duplex ingot costs are unfavorably influenced by ready availability of cheap scrap. By the same token, the process is regarded favorably during periods when scrap is expensive and in short supply.

There are, of course, other important economic factors affecting the rate of duplexing operations. While it is not within the scope of this paper to attempt an exploration of the economics, some general observations might be touched upon. The duplex plant requires higher initial investment, maintenance of proportionately large iron-making facilities, operation of more complex facilities (tilting open hearths and bessemer converters as opposed to stationary open hearths) and the related problems of transporting huge amounts of molten iron and steel. These factors may be balanced against the relative costs of iron and scrap, the ability to produce at high tonnage rates during peak operational periods, and the flexibility to meet both changing economic and quality conditions. In the final analysis it is probably true that the dividing line between favorable and unfavorable costs in the operation of large scale duplexing facilities may only be determined for the situation existing within the individual plant.

THE DUPLEX METALLIC CHARGE

The duplex metallic charge, usually consisting of at least 80 per cent bessemer blown metal, with from perhaps 5 to as much as 30 per cent iron directly from the blast furnace, is significantly deficient in the elements silicon and manganese, and high in phosphorus. The amount of carbon charged may be rather positively regulated, depending upon the degree of carbon oxidation in the bessemer converter, and the percentage of raw iron used in the open hearth. Sulphur in the charge depends upon the sulphur content of the iron, and thus is controlled at the blast furnace.

Since the duplex charge is substantially all blown metal and in some cases, entirely of blown metal, a brief review of the metalloid elimination in the acid bessemer converter may be undertaken with some value at this point. Figure 1 is included to illustrate the degree of elimination of the elements, carbon, manganese, silicon, sulphur and phosphorus, normally present in the iron charge to the converter.

Stated in simplest terms, the molten basic iron is oxidized by a blast of air under pressure which is blown through the bath from the bottom. According to the principles of mass action, the iron is first oxidized, forming ferrous oxide (FeO). The oxidation of silicon, manganese and carbon is effected by the ferrous oxide, their order of oxidation being governed by their respective heats of formation.

Thus, silicon and manganese are rapidly oxidized, in that order, in the early stages of the bessemer blow and their oxides are retained in the converter slag. As a result, the amounts of silicon and manganese carried over into the open hearth furnace are insignificant.

The acid bessemer process does not eliminate phosphorus and sulphur, since, though each may be oxidized, their oxides will not be retained by the highly acid, silicious slag. As the result of weight loss in blowing, the percentages of these elements are, in fact, increased somewhat in the converter operation. Thus, it is quite important that so-called basic iron for duplexing does not contain more than about 0.200 per cent phosphorus, nor sulphur exceeding about 0.045 per cent.

The amount of carbon oxidized in the converter may be controlled with fair accuracy. Since carbon is the last of the elements to be oxidized, the vessel may be turned down to provide duplex metal with carbon

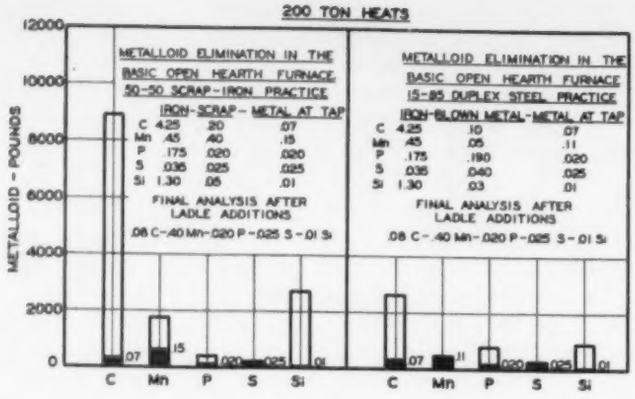

200 TON HEATS
METALLOID - POUNDS
METALLOID ELIMINATION IN THE BASIC OPEN HEARTH FURNACE 50-50 SCRAP-IRON PRACTICE
IRON-SCRAP-METAL AT TAP
C 4.25 .20 .07
Mn .45 .40 .15
P .175 .020 .020
S .035 .025 .025
Si 1.30 .05 .01
FINAL ANALYSIS AFTER LADLE ADDITIONS
.08 C-.40 Mn-.020 P-.025 S-.01 Si
METALLOID ELIMINATION IN THE BASIC OPEN HEARTH FURNACE 15-85 DUPLEX STEEL PRACTICE
IRON-BLOWN METAL-METAL AT TAP
C 4.25 .10 .07
Mn .45 .05 .11
P .175 .190 .020
S .035 .040 .025
Si 1.30 .03 .01
FINAL ANALYSIS AFTER LADLE ADDITIONS
.08 C-.40 Mn-.020 P-.025 S-.01 Si
C Mn P S Si

Figure 2 — This representation of the theoretical metallic charge of 200-ton heats of scrap and duplex steel reflects the significant differences in the amounts of the elements carbon, silicon and phosphorus to be dealt with in open-hearth refining.

anywhere from under 0.10 to as much as 2.00 per cent. When metal is provided to the open hearth at from about 0.10 to 0.20 per cent carbon it is commonly referred to as "full-blown." In modern practice the large percentage of duplex metal is ordered full-blown and the open hearth charge recarburized by additions of raw iron from the blast furnace.

When the carbon oxidation in the converter is stopped at some higher level, perhaps up to 1.00 per cent or more, the practice is called "young," or "high" blowing. Some duplex charges are made entirely of high blown metal, thus eliminating necessity for recarburizing iron. However, continuous operation of converters in this practice results in formation of kidneys, a build-up on the converter lining of a siliceous material which ultimately interferes seriously with production and must be removed with considerable difficulty. For this reason, high-blown practice is not generally employed.

A variation of the full and high blowing methods is a combination of the two, involving a "kicker" ladle of high carbon duplex metal, generally at the end of the fill-up, in place of raw iron. However, due to difficulty in providing an accurate carbon content in a 100 per cent blown metal charge, most operators prefer the better carbon control at fill-up provided by "full-blown" metal, and a known weight of iron of relatively predictable carbon content.

COMPARISON OF DUPLEX AND SCRAP METALLIC CHARGE

Contrasting the metallic charge of the duplex process with the scrap process reveals some interesting differences. Figure 2 is an expression of the amount of each of the five primary elements present in the metallic charge of two theoretical heats of 200 tons each. The first, a scrap heat charging 50 per cent raw iron and 50 per cent low carbon steel scrap and the second, a duplex heat charging 85 per cent blown metal and 15 per cent blast furnace iron. It is assumed that in each case the final analysis will be the same — that is, rimmed steel of 0.08 per cent carbon, 0.40 per cent manganese, 0.020 per cent phosphorus and 0.025 per cent sulphur.

It will be observed that appreciable differences in the amounts of carbon, manganese and sulphur are present in the respective charges. The differences of fundamental import, however, lie in the relative amounts of silicon and phosphorus.

Since silicon is virtually eliminated in the bessemer converter, the major proportion of the duplex charge is of very low silicon content. The use of blast furnace iron, of course, introduces some silicon to the charge, but it is generally true that duplex slags analyze appreciably lower in silica (SiO_2) than scrap hot metal slags. The comparative absence of silicon permits a relatively low slag volume in the duplex process — less than 200 lb per ton of steel. This is of great importance, since the combination of a low slag volume and the higher degree of fluidity common to duplex slags, promotes agitation and speeds the reaction processes through increased contact of the slag with the metal bath.

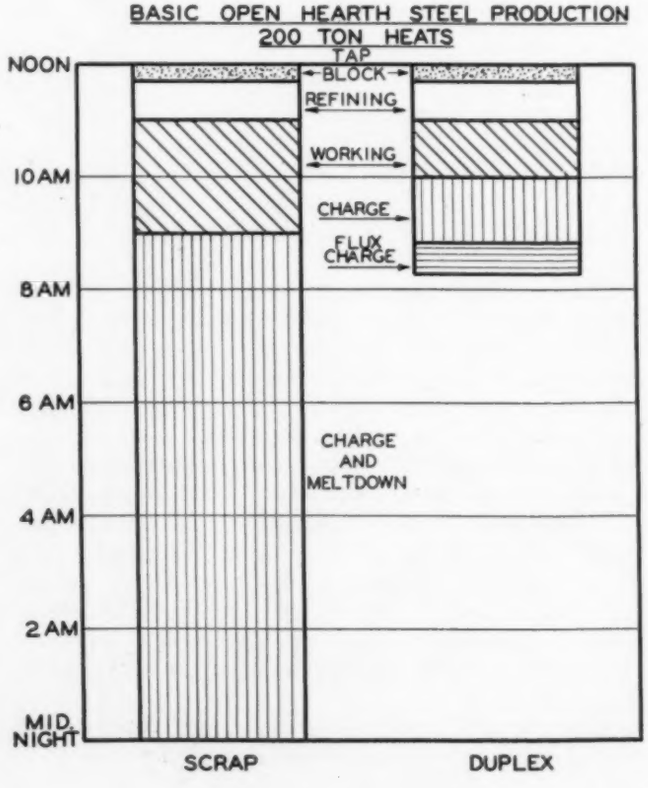
However, while the advantages of reduced slag volume are not to be denied, the presence in the duplex charge of large amounts of phosphorus, carried over from the acid converter, makes it imperative that the duplex slag be capable of oxidizing and retaining nearly twice as much phosphorus as the scrap practice slag.

The mechanism of phosphorus elimination consists of the oxidation of phosphorus to ferric phosphate by ferrous oxide (FeO) and its subsequent neutralization to calcium phosphate by the lime in the slag, as summarized in the single expression

$$2P+5\ FeO+3\ CaO=Ca_3P_2O8+5Fe$$

Thus, control of phosphorus depends primarily upon

Figure 3 — The important time advantage in duplexing results from elimination of the lengthy charge and melt-down interval of conventional practice.



high iron oxide in the slag, and high basicity in the form of excess lime. It is particularly important that duplex slags are properly controlled at the time of furnace additions containing silicon, since danger of phosphorus reversion to the metal exists unless the slag be sufficiently basic to accommodate additional acid reaction products. The higher silicon alloys are not favorable for duplex bath additions for this reason.

The relatively low slag volume natural to the duplex process also makes for a critical slag control problem in elimination of sulphur, since the reaction for removal of this troublesome element is generally believed to be favored by highly basic slags of weakly oxidizing character.[9] Thus, control of sulphur, considering the highly oxidizing character of open hearth slags, is best managed by stringent sulphur limitations on the blast furnace, and maintenance of a high percentage of equivalent lime in the flux charge to the duplexing furnace.

Flushing a large quantity of the reaction slag at time of the raw iron addition, and subsequent building of a new slag with flux addition is an effective practice for improving the ability of the light duplex slag to hold phosphorus and sulphur.[8]

The elimination of carbon from both the duplex and scrap charges proceeds according to the reaction:

$$C+FeO \rightarrow CO+Fe$$

There is, however, a fundamental difference between the two processes in the mechanism of bringing the reactive substances together.

In the conventional scrap practice, iron oxide is first formed during the meltdown period when the steel scrap is directly exposed to the highly oxidizing furnace gases. Once the heat is largely melted and "under cover" of the slag blanket, the oxidation of the bath takes place through diffusion of iron oxide from the slag to the metal. The rate of diffusion has an important bearing upon the time of heat and upon steel quality, and is largely determined by fluidity and composition of the slag, the contact of the slag with the metal through agitation, the amount of iron oxide in the metal and, of course, temperature. In order to speed the rate of carbon elimination, through the medium of bringing the reactive substances together, it is established practice to make direct addition of iron oxide (ore) to the bath, thus promoting the carbon "boil."

In the duplex practice, assuming the conventional use of "full" blown converter metal of low carbon content and a raw iron recarburizer, the duplex metal carries with it a relatively high iron oxide content from the bessemer process. To reduce this oxide to iron, and to bring about association of the reactive elements, carbon is added in the form of raw iron, or, of high-blown duplex metal. The addition of the high carbon metal produces a violent reaction, caused by the evolution of carbon monoxide, as expressed previously.

This reaction, or "boil," intermixes the slag and metal thoroughly and rapidly removes the carbon, in the form of carbon monoxide which goes off in the furnace gases, in addition to removing the phosphorus, silicon and manganese whose oxides rise into the slag. When a condition approaching equilibrium has been reached between the carbon and iron oxide in the bath, the heavy boil in the furnace is ended, and the elimination of additional carbon proceeds, as in scrap practice,

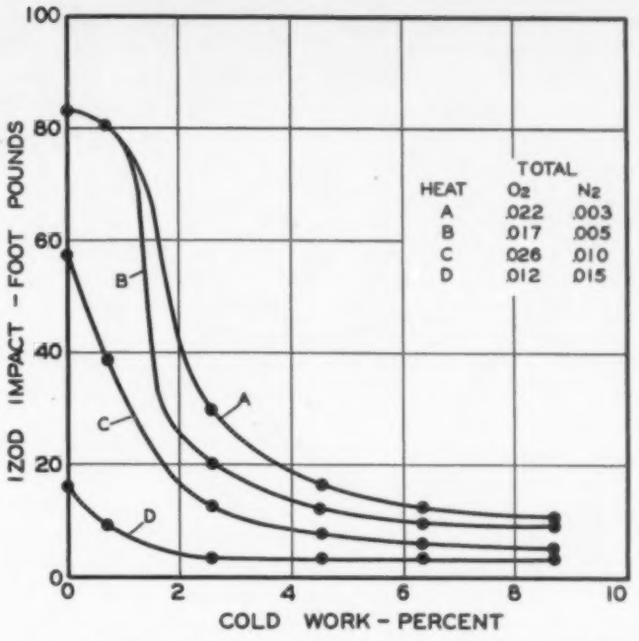


Figure 4 — For four rimming steels, increasing strain-sensitivity in work brittleness testing is shown with relation to increasing nitrogen. Oxygen content does not appear significant.

primarily as the result of the diffusion of iron oxide through the slag to the metal. The relatively light slag volume, and the increased fluidity of duplex slags, favors the speed at which carbon may be eliminated during this latter phase.

Thus, in comparison of the two practices with respect to carbon elimination, we may summarize as follows:

1. In scrap practice, carbon is present in the bath, and iron oxide in the form of ore, is added to supplement the diffusion of iron oxide from the slag. The resultant "boil" hastens the process through bringing the reactive substances together.
2. In duplex practice, the iron oxide is already present in the low carbon blown-metal bath. Therefore, carbon in the form of raw iron or high carbon duplex metal, must be added to promote the "boil."

DUPLEX AND THE ELEMENT OF TIME

Time, as an element in steelmaking, is frequently the subject of at least some degree of popular misconception. There is the belief extant, for example, that the quality of finished product is directly proportional to the time consumed in its manufacture. As a matter of fact, something akin to the direct reverse is closer to the truth. Under best conditions, at steelmaking temperatures, the time required for the chemical, physical and thermal reactions to come to completion and establish desirable states of equilibrium is very short. Any excess time, permitting over-oxidation, consumption of furnace lining, etc., is highly undesirable.

In the duplex process, time is of considerable importance, since it is because of the inherent speed of the operation that it has survived. For example, a tilting furnace producing duplex steel has a tonnage output approximately two and one-half times that of a sta-

tionary furnace operating on a 50 per cent scrap, 50 per cent hot metal charge. Thus, although investment costs for installation of tilters is greater than for stationary furnaces, and despite higher maintenance costs of the more complex machinery, the costs per ton of steel produced are closely comparable.[8]

It is, of course, in the employment of a 100 per cent molten charge that duplexing gains its great advantage over the conventional practice. Fundamentally, scrap open hearth steelmaking consists of charging, melting-down and refining. Charging of the scrap and flux materials and heating this charge to a molten state with chemistry suitable for subsequent refinement, occupy at least two-thirds of the total furnace time in the conventional practice. See Figure 3. The refinement phase consists of the action of the fluxes, slags and deoxidizers on the metal. During this period, the important factors are proper temperature to induce rapid chemical reactions, and mechanical agitation to permit optimum contact between all elements of the charge in order to facilitate chemical and solubility equilibriums, with ultimately the maximum amount of separation of slag from the metal.

In the duplex practice, the metallic charging of a 150-ton tilting furnace, following a 45-minute period during which the fluxing materials are charged and melted, may be accomplished in about one hour. There is of course no meltdown period and the working of the heat may proceed immediately upon addition of the iron or high carbon blown metal. The degree of mechanical agitation and contact at high temperature, is such that some of the refining work has already been done upon completion of the charge, enabling the most effective finishing of the heat at a fast rate.

In consideration of these factors, it may be observed that the shorter time required to produce steel in the duplex process is undoubtedly advantageous from the production standpoint and also is of benefit to the ultimate quality.

METALLURGICAL CONTROL OF DUPLEX STEELS

It is noteworthy that the many technical papers written to describe the duplex process during the forty-year period from 1890 through 1930 make almost no mention of the metallurgical quality of duplex steels. There is an occasional brief reference to quality, generally a statement to the effect that the chemical and mechanical properties were found to be the equal of those associated with conventional practice steels. One author observed in 1915[10] that service records for rail steel made in both scrap and duplex practices showed "a smaller percentage of failures from duplex metal than from cold charge heats." But beyond such very general observations the subject of quality received no attention, at least in the published literature.

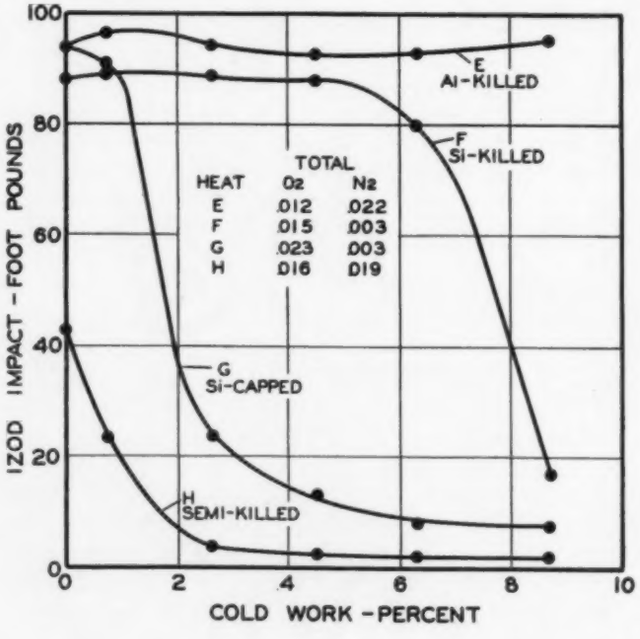
During the past twenty years, however, the metallurgical quality of duplex steels has been afforded the benefit of intensive research, spurred by the realization that there were significant differences in the product of the scrap and duplex furnaces which could not be revealed by comparison of common chemical elements, nor by conventional methods of static testing. Most significant of these differences was found to be the higher level of "sensitivity,"[11] or rate of reaction to cold work, observed in the dynamic properties of some duplex steels.

The sensitivity of steels — that is, their relative rate of cold work embrittlement, is a property of the greatest commercial significance. Steels with characteristically high levels of work-embrittlement find their field of useful application narrowed to a marked degree. For example, such steels may not be used successfully for parts subject to severe deformation in forming, cold upsetting, or deep drawing. On the other hand, sensitive steels are superior to insensitive steels of comparable grade, from the standpoint of machinability, fatigue endurance and temper-rolled or cold-worked stiffness.

It has been recognized early in the study of duplex dynamic properties that this steel, although exhibiting a generally higher order of sensitivity than scrap practice steel, was not consistently more responsive to cold work embrittlement. That is to say, duplex steels, *per se*, need not be more sensitive than the product of the conventional practice. In fact, by means of the work-brittleness test,[12] investigation determined that steels of high and low degrees of sensitivity could be found in both practices, but that greater variations in sensitivity were evident from heat to heat of duplex steels. It was learned, for example, that some duplex steels approached the work-embrittlement characteristics of bessemer heats, while others were no more susceptible to cold work embrittlement than were the least sensitive scrap steels.

An interesting demonstration of the variable sensitivity of duplex may be found in Epstein's study relative to embrittlement of cold-punched galvanized structural angles.[13] In this work, in which bessemer, duplex, scrap open hearth, and the German Izett steels, were subjected to a series of tests designed to reflect their respective susceptibility to cold-work embrittlement, it is reported that bessemer steel was most sensitive, followed by duplex, scrap and Izett in that order. In

Figure 5 — The influence of deoxidation practice upon normally sensitive steels. Note that steel E, aluminum killed, is least sensitive despite highest total nitrogen content.



the case of the duplex material, however, attention is called to the fact that in some individual tests, duplex angles were superior to scrap angles.

CONTROL OF SENSITIVITY

The unique metallurgical flexibility inherent in the product of the duplex practice is primarily dependent upon control of its wide range of sensitivity characteristics. Modern practice has achieved this control, to the extent that these steels may be universally applied to fulfill the requirements expected of the best scrap practice steels. Control of nitrogen has been, without question, the greatest single factor in this achievement.

It has long been recognized that the amount of nitrogen present in solid steels of the low-carbon rimmed, capped or semi-killed types, exerts a substantial influence upon their strain-aging characteristics and upon their rate of response to cold work. Since deoxidation generally serves to minimize susceptibility to both aging and strain-sensitivity, the influence of oxygen dissolved in the solid steel has also been extensively studied. It is difficult, however, to show definite relationship of oxygen to the aging and work-sensitivity of open-type steels while direct relationship can be shown for nitrogen and these properties.

Figure 4 from the paper of Work and Enzian[14] illustrates the increased strain-sensitivity of four rimming steels with increasing nitrogen contents. Note that steel A, with lowest nitrogen content, is least sensitive and that steel D with highest nitrogen is most sensitive. No correlation with oxygen content (determined by vacuum-fusion gas analysis) is evident.

Figure 5, also from Work and Enzian, illustrates the influence of deoxidation practice upon normally sensitive steels. It will be observed that steel E, aluminum killed, with the highest total nitrogen content and the lowest total oxygen content, is least sensitive to cold work. Heat F, silicon-killed, is more sensitive than Heat E, despite considerably lower nitrogen content, thus illustrating that silicon deoxidation is not as effective as aluminum deoxidation in promoting insensitivity. Figure 6 shows the comparative effects of silicon and aluminum deoxidation upon strain-sensitivity of normally sensitive steels.

Since the effects of nitrogen are largely minimized in deoxidized steels, the control of nitrogen content of duplex steels becomes of importance primarily in the low-carbon steels of the rimmed or semi-killed types.

Full-blown bessemer metal will ordinarily contain between 0.011 to 0.020 per cent nitrogen, with average at perhaps 0.015 per cent. Blast furnace iron seldom contains nitrogen in amounts exceeding about 0.005 per cent and will range down to 0.002 per cent. Scrap — that is, scrap steel originating from the scrap-hot metal practice — generally will analyze between 0.003 and 0.006 per cent nitrogen. Considering the bessemer origin of duplex steels, it follows that nitrogen content of the duplex product may be expected to average consistently higher than the product originating from the scrap-raw iron charge, unless — (1) bessemer metal can be produced with nitrogen equivalent to the total nitrogen in the scrap and iron or (2) effective means are employed to eliminate nitrogen in the working of the duplex heat in the open hearth furnace.

NITROGEN CONTROL

The possibilities for effective nitrogen control in the bessemer operation are limited to production of blown metal with nitrogen at a somewhat higher level than may be tolerated in duplex steels intended for applications demanding a low order of sensitivity. It has been demonstrated that the amount of nitrogen in solution in blown metal is primarily dependent upon the temperature of the blow.[15] The length of blow has also been found to have an effect upon nitrogen in solution.[16] Thus, with control of blowing temperature (largely a matter of control of silicon in the iron) and the blowing time, it is possible to avoid extremes of nitrogen, and provide metal to the open hearth on the low side of average nitrogen expectancy.

This control, while not at present effective in providing blown metal with nitrogen at a sufficiently low level to permit universal application of the duplex product, is of considerable importance in that it minimizes necessity for dealing with the extremes of nitrogen which may only be handled with much difficulty at the open hearth. Were it possible to produce duplex metal in the bottom-blown converter, ranging from 0.004 to 0.008 per cent nitrogen there would, of course, be little necessity for further elimination. Since side-blowing, or surface blowing, extensively practiced in foundries, will produce low-nitrogen metal, considerable attention has been given in recent years to this practice. However, with existing large-scale facilities, it is still necessary, for positive control of duplex sensitivity, to effect the critical nitrogen elimination at the open hearth.

CONTROL OF NITROGEN IN THE OPEN HEARTH

The elimination of nitrogen in the duplexing open hearth, is favored by active bath conditions (with activity promoted as early in the fill-up as is practical under existing conditions) and the rapid elimination of carbon during the refining stage. In the case of the full-blown duplex charge, assuming the recarburizer is not added until the blown metal charge is complete, the bath will, until the iron addition, be quite low in carbon and thus inactive. Nitrogen will not be removed until bath activity is promoted by the addition of carbon. From this point — that is, the beginning of the carbon-iron oxide reaction — until the heat is tapped, the degree of nitrogen removal will depend upon two factors:

1. The amount of carbon, in excess of the tapping carbon, at fill-up.
2. The rapidity with which the carbon is eliminated during subsequent working of the heat.

In order to provide sufficient excess carbon at fill-up to permit the degree of rapid working of the heat necessary to achieve very low nitrogen in the finished steel, some penalty in furnace production must be accepted. The fact that it is primarily the low carbon rimmed or semi-killed grades that require low nitrogen practice, serves to accentuate the loss in tons per hour. However, the increased time required is not enough to seriously interfere with the time advantage inherent in the duplex process.

Since an active bath is effective in the elimination of nitrogen, it has been found advantageous to promote

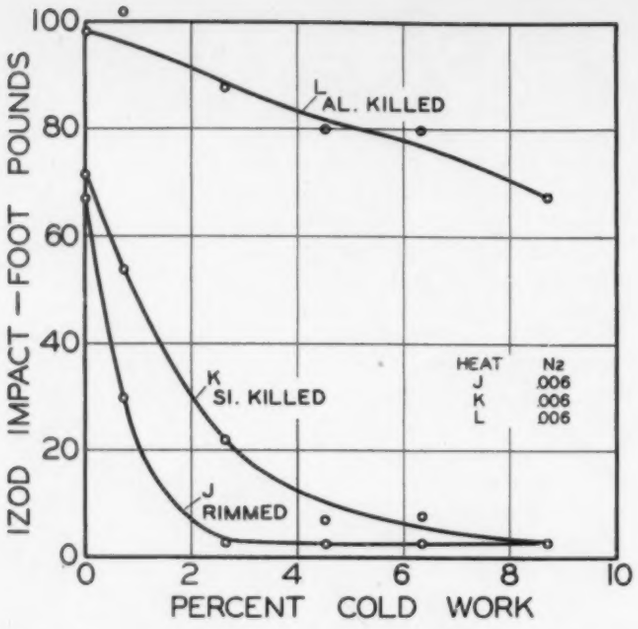


Figure 6 — The comparative effects of aluminum and silicon deoxidation upon sensitivity of steels of identical nitrogen content.

early activity by intermixing high-blown metal with low carbon full-blown metal in the fill-up. The iron addition may also be made at an intermediate stage. Properly employed, these methods, of which there are several variations, will enable some effective elimination of both carbon and nitrogen during the charging period, with appreciable savings in the total time of heat.

It has been established that skillful application of these recognized principles will consistently produce low-carbon rimmed or semi-killed steels with nitrogen at the level of best scrap practice.

DUPLEX AND RESIDUAL ALLOYS

Entirely apart from the metallurgical advantages which exist by virtue of the range of sensitivity characteristics possible with control of nitrogen in the duplex process, is the relative freedom of duplex steels from contamination by tramp or residual alloys.

It is recognized that small amounts of the elements — nickel, chromium, copper, tin, etc. — can have appreciably serious effects upon the ductility, weldability and surface quality of some steels. The steel plant employing the scrap-hot metal open hearth practice, and thus dependent to rather large extent upon purchased scrap, must exercise considerable caution, therefore, to avoid the use of scrap containing harmful amounts of these elements in charging heats intended for deep drawing sheets, butt- or lap-welded pipe, etc. Unfortunately, the unprecedented conditions of the past ten years, have served to greatly increase the percentage of alloy-bearing scrap returning to the steel works for remelting. As a result, segregation of such scrap for use in heats where the residual alloy content will not be harmful, has become a problem of considerable magnitude.

Duplex steel, with its 100 per cent origin from ore, and its freedom from use of miscellaneous scrap, is singularly unaffected by residual alloys. Thus, its use for application where relatively small amounts of tramp elements may be harmful, provides a desirable flexibility for the plant employing both the scrap and duplex processes.

SUMMARY

In this discussion of the duplex process, an attempt has been made to outline some of the background, distinctive characteristics, and metallurgical features of a commercially important steelmaking method. It has not been possible, considering the scope of the subject, to do complete justice to all points of interest and it is recognized that some items of importance have not been afforded detailed attention.

However, some of the points that have been discussed may be summarized briefly as follows:

1. The method of duplexing with the combination of acid-basic facilities originated in Europe, but never achieved complete commercial acceptance there, or in England, and was ultimately discarded for economic reasons.
2. The duplex process was first practiced in America in 1904 and gained a rapid acceptance by virtually all large steel producers. A combination of economic factors in the period following the first World War saw the number of duplexing operations reduced. The process is operated on a consistently large scale at present by only two producers — the Tennessee Coal, Iron and Railroad Company and the Jones and Laughlin Steel Corporation.
3. Several factors influence the economics of duplexing. The cost and availability of heavy melting scrap have important bearing upon the rate of duplex operation. It is mentioned that the dividing line between favorable and unfavorable costs of large scale duplexing may only be determined for the situation existing within the individual plant.
4. Fundamentally, the duplex metallic charge differs from conventional practice only in that blown metal from the bessemer converter is substituted for cold scrap. The fact that carbon, silicon and manganese are largely eliminated from the iron in the converter makes for important differences in the manner and rate of metalloid elimination in the respective processes.
5. The important time advantage inherent in the duplex process, permitting a tonnage output approximately two and one-half times that of a stationary furnace charging 50 per cent scrap and 50 per cent iron is the result of elimination of lengthy charging and meltdown periods through means of the entirely molten duplex metallic charge. It is believed that the shorter time required to produce steel in duplexing is also of advantage to the ultimate steel quality.
6. Intensive metallurgical investigation during the past twenty years has served to explain and control the degree of "sensitivity," or cold work embrittlement, of duplex steels. Sensitive steels are superior to insensitive steels of comparable grade from the standpoint of machinability, fatigue endurance and cold-worked stiffness. They may not be successfully used for parts subject to severe cold work, such as deep

drawing or upsetting. Control of sensitivity provides for unique metallurgical flexibility in the product of the duplex process.

7. Sensitivity of duplex steels is associated with the amount of dissolved nitrogen remaining in the final product. Modern practice, involving control of temperature and length of the bessemer blow, and of the carbon fill-up, and rate of carbon elimination in the open hearth, enables production of duplex steel with nitrogen at a level comparable with best scrap practice.
8. Duplex steels are singularly free of contaminating residual elements harmful to some important steel applications. For the plant employing both the scrap and duplex processes, this provides an additional advantage of flexibility.

BIBLIOGRAPHY

1. *History of the Duplex Process*, by P. Eyermann, Stahl und Eisen, 1934, Vol. 54, pp 1320-21.
2. *On the Dephosphorization in the Bessemer Converter by the Method of Repouring*, by H. G. Harmet, J.I.S.I. 1879, p 150.
3. J.I.S.I. 1885, p 614.
4. *On the Manufacture of Basic Steel at Witkowitz*, by Paul Kupelweiser, J.I.S.I. 1893, p 6.
5. Engineering and Mining Journal, Vol. 77, p 399.
6. Engineering and Mining Journal, Vol. 44, p 293.
7. *The Use of Blown Metal at Weirton for Making Open Hearth Steels*, by Gold and Newbrander, 25th O. H. Proc., A.I.M.E., Vol. 25, 1942.
8. *The Duplex Process for the Manufacture of Basic Open Hearth Steel*, by Emerich and Feigenbaum, 25th O. H. Proc., A.I.M.E., Vol. 25, 1942.
9. *The Control of Iron Oxide in the Basic O. H. Process*, by Herty, Christopher, Freeman, Sanderson, Mining and Metallurgical Advisory Boards, Co-Op Bulletin No. 68.
10. *Making Steel by the Duplex Process*, by Martin, Iron Age, Vol. 95, 1915, p 75.
11. *A Modern Conception of Steel Quality*, by Graham, Yearbook, A.I.S.I. 1932, pp 59-114.
12. *A Work Brittleness Test for Steel*, by Graham and Work, Proc. A.S.T.M., 1939, Vol. 39, pp 571-582.
13. *A Study of the Embrittlement of Hot Galvanized Structural Steel*, by Epstein, Proc. A.S.T.M., 1932, Vol. 32, p 2.
14. *Effect of Deoxidation on the Strain-Sensitivity of Low-Carbon Steels*, by Work and Enzian, Transactions, A.I.M.E., 1945, Vol. 162, pp 723-731.
15. *The Acid Bessemer Process of 1940*, by Graham, Transactions, A.I.M.E., 1941, Vol. 145, pp 113-129.
16. *Photo-cell Control for Bessemer Steelmaking*, by Work, Transactions, A.I.M.E., 1941, Vol. 145, pp 132-150.

DISCUSSION

PRESENTED BY

DR. G. E. WILLEY, Algoma Steel Corporation, Sault Ste Marie, Ontario, Canada

D. T. ROGERS, Assistant Director of Technology, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania

H. F. LESSO, Open Hearth Control Metallurgist, Great Lakes Steel Corporation, Ecorse, Michigan

H. E. PHELPS, Electric Furnace Superintendent, Rotary Electric Steel Company, Detroit, Michigan

L. U. DAVIS, Jones and Laughlin Steel Corporation, Detroit, Michigan

J. A. CLAUSS, Vice President in Charge of Engineering, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

Dr. G. E. Willey: Mr. Rogers, you mentioned in your paper the effect of nitrogen and oxygen in duplex steel, but you did not say anything about the effects of hydrogen. What about the susceptibility of duplex steel to flakes and shatter cracks?

D. T. Rogers: As far as we have information, there is not any appreciable difference in the end-product hydrogen content of the duplex and the conventional scrap processes. I do not know that any direct correlation has ever been made, nor have I knowledge that duplex steels have ever been regarded as more prone to flaking associated with hydrogen than the conventional practice steels.

It might be added that it has been shown that absorption of hydrogen during tapping and teeming can be of greater influence than the way in which the steel has been refined.

H. F. Lesso: In the oxidation-reduction cycle on an average heat of basic open hearth steel with a conventional scrap-metal charge, the "low point" in the ferrous oxide content of the metal develops about two to three hours after the hot-metal additions. This "low ferrous oxide point" being influenced by:

1. The degree of melting prior to the hot metal addition.
2. The silicon content of the hot metal; and usually occurring at a CaO-SiO_2 ratio of unity; also this low point in contained ferrous oxide being a relative measure of the ultimate refining time.

Can you tell me where this "low point" develops in the blown metal practice?

D. T. Rogers: The very low point in the ferrous oxide content of a duplex heat will develop at some point shortly after the raw iron (or high carbon blown metal addition) has had time to largely complete the carbon-iron oxide reaction in the furnace. Just where the point would come would depend upon several variables, including the degree of oxidation in the bath at time of iron addition, the amount of iron charged, silicon content of the iron, etc.

H. F. Lesso: Is that a primary function of the metal added?

D. T. Rogers: Yes. Of course, the amount of iron oxide in solution in liquid steel is dependent primarily on the carbon content. We have considerable data to show that there is a greater amount of iron oxide in solution in duplex steels than in scrap steels for a given carbon content. This is due to the rapidity of the duplex refining process, preventing the degree of approach to equilibrium conditions for the C-FeO reaction attained in the slower scrap practice.

H. E. Phelps: Mr. Rogers, did I understand you correctly to say that your slag volume is approximately 200 pounds per ton?

D. T. Rogers: Yes, ordinarily less than 200 pounds per ton of steel.

H. E. Phelps: Do you consider that low?

D. T. Rogers: Yes. Relatively low.

H. E. Phelps: Do you know about what the V ratio would be in that?

D. T. Rogers: We have not been able to do much with V ratio on duplex slags. It can be said that duplex slags are regularly lower in silica and higher in the oxides of iron and phosphorus than scrap practice slag. The lower SiO_2 content more than balances the higher P_2O_5 content from the standard of basicity.

H. E. Phelps: P_2O_5 is higher, of course. When you are speaking of your ratio, do you mean SiO_2 plus P_2O_5?

D. T. Rogers: Normally, yes.

H. F. Lesso: In reference to the temperature of your blown metal, which you, I believe, stated was a function of the silicon, can you tell me what would be the approximate recovery of the heat energy that would be developed in your blowing operation? That is, heat energy retained in blown metal in Btu per ton versus the heat energy developed in the conventional iron in a scrap-metal charge.

D. T. Rogers: I am afraid that I cannot answer that one for you offhand.

H. F. Lesso: Approximately how much hotter is your blown metal than your conventional iron?

D. T. Rogers: The iron charged to the converter from the mixer will probably average somewhere in the neighborhood of 2400-2500 F. The blown metal, generally speaking, will run in the neighborhood of 2850 F to somewhat higher. In the side-blown converter practice used extensively in foundries, temperatures may run to 3100 or 3200 F. There, of course, high temperature is very desirable for fluidity necessary to permit pouring a number of very small castings. But normally, the blown metal for duplex practice will average close to 2850 F.

Dr. G. E. Willey: What do you recommend for blocking your duplex heats? What deoxidizers do you use?

D. T. Rogers: Considering the danger of adding any excess silica and increasing the acid reaction products in an already straining slag, the higher silicon alloys are avoided as blocking materials for duplex practice. There is always danger of P_2O_5 reversion.

L. U. Davis: We have used 11 per cent ferro-silicon and silico-spiegel as a duplex block at J & L.

Dr. G. E. Willey: What is the analysis of the silico-spiegel?

L. U. Davis: It is 4 per cent carbon, 20 per cent manganese, and about 4 per cent silicon.

H. F. Lesso: Mr. Rogers, you stated that an extremely violent reaction results when you make the addition of blown metal to the furnace. Can you tell me what effect such reaction has on the roof life? This reaction is of particular interest, for I believe Mr. Earl Smith of Republic Steel has reported that when silica refractories carry a film of iron oxide, the refractory properties of the silica brick are not too seriously impaired providing the atmosphere is oxidizing in character. However, when reducing atmospheres prevail, the ferrous oxide is reduced to ferrous iron which is readily dissolved by the silica refractory, forming the low melting point iron silicates, "grunerite and fayalite."

D. T. Rogers: I cannot answer that question directly. It could be guessed that violent furnace reaction and increase of temperature would have an adverse effect upon roof life, but I would have to go to our operating department for figures to answer your question.

J. A. Clauss: We, of Great Lakes Steel, are particularly interested in this paper, as we now have under construction a bessemer converter plant. It may be of interest to learn that in September, 1864 in our neighboring city of Wyandotte the first bessemer steel was made in the United States by Mr. William F. Durfee, of the Kelley Pneumatic Process Company, in a 2½-ton experimental converter. In James M. Swank's "History of the Manufacture of Iron in All Ages" is an interesting account of this early effort in the making of bessemer steel. Mr. William F. Durfee has described in the following words the quality of the Bessemer steel first made at Wyandotte:

"Various experiments were tried to test the ductility and working qualities of the steel produced at Wyandotte. Some of the early product was sent to Bridgewater, Massachusetts, and there rolled into tack plate and cut into tacks which were pronounced to be very superior to any previously made of iron. In order to test the welding qualities of the steel, John Bishop, the blacksmith of the works, made a tobacco-pipe of the size of an ordinary clay pipe, the bowl and stem of which were welded up of Wyandotte steel, and when perfectly polished there was no visible evidence of a weld. I now have two jack knives and a razor made from this steel; the knives are rather soft, but the razor was used regularly by my father for fifteen years to his entire satisfaction."

It seems rather strange that, after a lapse of nearly 83 years, we should be building bessemer converters in Ecorse on a site which is only a few miles from the first bessemer location in Wyandotte.

The bessemer converter plant being built by the Great Lakes Steel Corporation will consist of two 25-ton converters located west of and adjacent to the 1300-gross ton mixer, which is located at the west end of our No. 1 Open Hearth Plant, in which are located twelve 200-ton open hearth furnaces.

For blowing the converters, there is being installed one 45,000 cfm motor-driven blower at 30 psi pressure. The plant will be complete and equipped with the most modern equipment.

The arrangement is such that straight bessemer steel can be made or the iron partially blown for further refinement in the open hearth furnaces. These converters are being installed primarily to increase our open hearth steel production by partially blowing the iron in the converters. This partially-blown metal will be delivered in a 75-ton transfer car to the open hearth furnaces for further refining, or it can be fully blown and delivered to the pit side of the open hearth plant for teeming into ingot molds if bessemer steel is desired.

Practically all of the equipment and buildings for this installation have been ordered and actual field work will begin in April, and it is hoped to have the plant in operation by October, if the equipment is delivered as promised and there are no labor difficulties.

H. F. Lesso: Mr. Rogers, what has been the minimum slag volume you have been able to carry? You stated that 200 pounds per ton was the optimum, what was the actual minimum?

D. T. Rogers: If your question is: How low a slag volume could you operate a duplex furnace on?, I do not know the answer. The 200 pound per net ton figure I used was representative of average duplex performance.

H. F. Lesso: The reason I have asked the question, the late Mr. Sweeney of Republic Steel had reported from investigations he had conducted, that they were able to go as low as 3½ per cent. Your 200 pounds in a 200-ton furnace is substantially higher than Republic Steel's findings.

RECENT DEVELOPMENTS IN REFRACTORIES

. . . . trends in the use of refractories are toward greater use of carbon hearths in blast furnaces, super-duty brick, basic-end furnaces, and open-hearth bottoms of magnesite brick with a layer of sintered magnesite on top . . . .

By H. M. KRANER, Engineer of Research
Bethlehem Steel Company
Bethlehem, Pennsylvania

▲ A refractory is a material or compound capable of enduring a high temperature without "softening." It is used to construct or line furnaces in which useful heat application is carried on. Refractories are made of many minerals which are available to us in nature. By forming and firing or fusing these minerals, we make construction materials of them which are suitable for high temperature purposes. In not very many cases can we add minor constituents to a natural pure refractory material to make it more refractory. Generally, the fusion point is lowered. This is the action which takes place in a furnace where materials foreign to the refractory flux it down. Frequently when conditions are severe, operators resort to water-cooling. Examples of this are common. The modern blast furnace is dependent upon water-cooling in the hearth, bosh and stack. Bosh refractories would last only a few days without intense water-cooling. Stack lines have been held for many extra tons production of the furnace by external water-cooling. Hearths are held by retardation of refractory wear through water-cooling. Many hearth failures are the result of poor water-cooling. Open-hearth furnaces require water-cooled doors, door frames, burners, ports, slag line and bridge wall coolers to allow them to operate successfully. A well-known recent development in open-hearth doors maintains itself on its water-cooling. This is the rammed door which, it is claimed, lasts longest when the thickness of the chrome cement is only ½ in. when the water-cooling has actually begun to be the most effective refractory. One furnace now being used in industry uses no refractory whatever. This furnace is a rotating shell containing the slag charge which is heated by direct impingement of the flame on the charge inside the furnace. Rotation of the shell spreads the molten slag on the inner surface where it sticks. As the shell is water-cooled, a slag lining adheres and is maintained by being frozen to the shell. A particular cement mill furnace is another example of this type. There are many other cases of this kind too numerous to mention, each of which attests the inadequacy of refractories and the success of water-cooling.

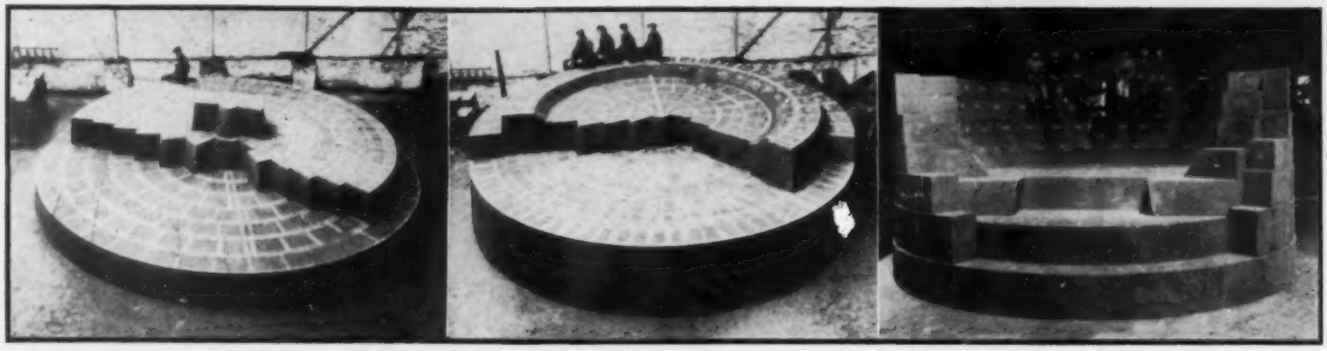
It is probable that this will always be so wherever a refractory must resist the action of molten slags at high temperatures. Any liquefied combination of oxides heated above its melting temperature has potential solubility for more of its constituents or for any other constituents such as refractories with which it may come in contact. Only a slow rate of solution will allow refractories to exist under severe slagging conditions. We then must acknowledge that the one and only purpose for using refractories is to save heat. In many cases it is the economical thing to do, to expend heat through water-cooling to save repair time, but there is a practical limit to which we can go in this direction as there comes a time when one cannot supply heat fast enough to attain the temperature necessary to accomplish the purpose. Careful consideration must therefore always be given to the economics of water-cooling versus refractory costs and furnace time.

BLAST FURNACE LININGS

The blast-furnace lining suffers from alkali attack and disintegration by carbon deposition in the stack. Resistance to both of these is increased by hard firing of standard refractories, and by the use of somewhat more refractory clay refractories, also hard fired. The latter are called "super-duty" refractories, although their actual fusion points are only slightly higher than the so-called first-quality brick.

The brick of the hearth of a blast furnace should be

Presented before AISE Buffalo District Section Meeting, January 14, 1947



Figures 1, 2, and 3 — Carbon hearth construction used in Germany is shown in these three views.

sufficiently refractory so that they are volume stable, to withstand the temperature and ferrostatic pressure. Most hearth brick are pyroplastic near the working face of the crucible and shrink, thereby allowing metal to penetrate to greater depths of the brickwork. One recent case of the writer's experience showed that during the first 25 days of operation, metal had penetrated the pore of the blocks to within 2 feet of the lowest bottom block.

Clay refractories for blast furnace use have from 14 to 22 per cent porosity. This is what is known as "apparent" porosity. In addition there are appreciable quantities of sealed pores into which water cannot penetrate in the usual refractories porosity test. These sealed pores represent potential shrinkage just as well as those into which water or metal can penetrate in the "apparent porosity" test. A hard-fired refractory may therefore have a low apparent porosity, and yet have a high sealed-pore content. The total porosity should be taken into account.

We are quite casual in the consideration we give to bulk density of refractories for hearth service. The bulk density of hearth blocks varies from 2.15 to 2.35. In a 25-foot hearth a difference in bulk density of 0.20 makes a difference of about 30 tons of brick.

Figures 1, 2 and 3 show carbon hearths as made by the Germans. Figures 4, 5 and 6 show a large block hearth as has been produced in this country.

Carbon may be one answer to the shrinkage problem. It is extremely refractory and does not become pyroplastic at operating temperatures. The bath is saturated with carbon and the hearth carbon will therefore not be attacked by the bath.

The trend in blast-furnace linings is therefore quite definitely toward hard-fired refractories, super-duty quality refractories and, carbon for the hearth; carbon being limited to the hearth. The last has not been proven to the extent of the other two. Super-duty brick are generally made of Missouri fire clays which fire to greater density than most other types. Super-duty implies greater refractoriness. While these brick have a fusion point only 20-35 F higher by actual measurement, this, plus their greater volume stability and higher density, is in their favor. Not all super-duty brick resist disintegration by carbon deposition in an atmosphere of carbon monoxide.

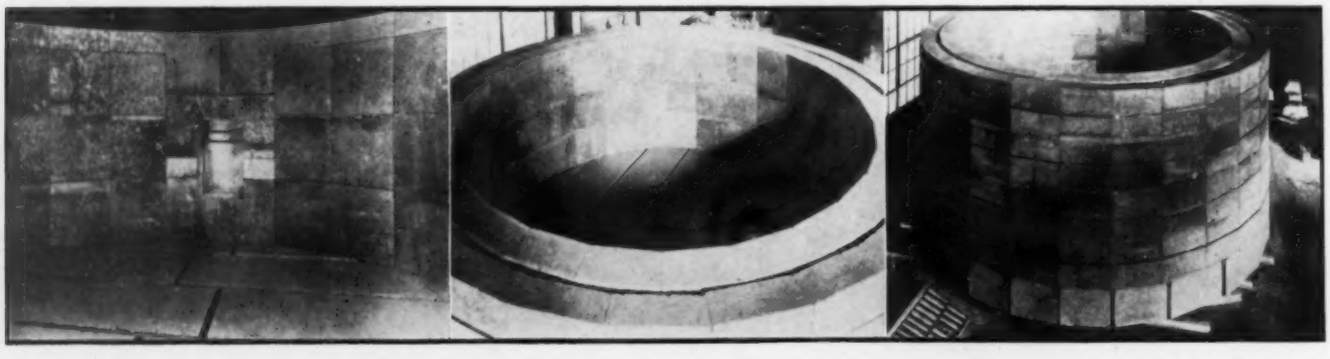
The use of super-duty brick has been vastly increased in the last five years. They have found wide application in the steel plant, particularly in reheating-furnace roofs, sidewalls, etc., where they show definite superiority over the so-called "first quality" brick. During this time we have installed the first blast furnace linings of super-duty quality clay brick. As these brick are more refractory and volume stable, they are expected to render considerably better service.

SILICA BRICK

In 1913, Dr. Fenner, of the Geophysical laboratory, gave us a clear idea of the stability relations of the silica minerals developed by heating quartz and other silica materials to high temperatures. The information has been the basis of all of our testing of silica brick in the laboratories of both the manufacturer and consumer. Cristobalite, tridymite, and the density of silica brick were our sole criteria of judging good or bad brick. Not until four or five years ago did we give ample consideration to the pyrochemical properties of the silica brick used in open hearths. Irregularities in roof life were then generally attributed to abuse by the operators.

Careful checks, however, have shown that small dif-

Figures 4, 5, and 6 — Carbon hearths in the United States use much larger blocks than the German practice.



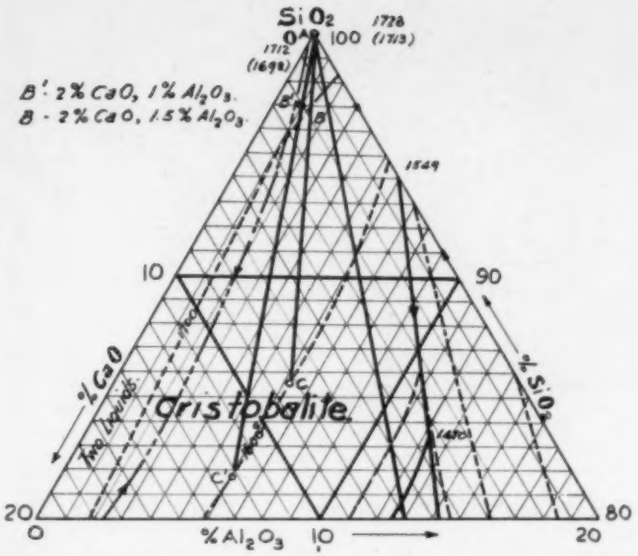
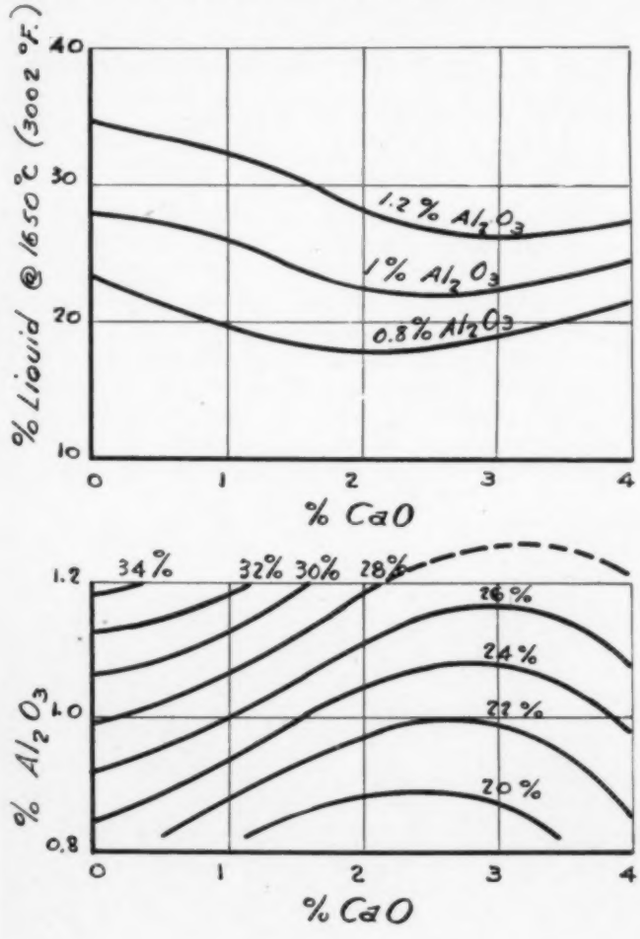


Figure 7 — A section of the lime-alumina-silica equilibrium diagram is here shown.

ferences in the flux contents of a brick make big differences in open-hearth roof life. A normal alkali content is around 0.1 per cent, normal alumina content around 0.8 per cent. Any small increase in either of these seriously decreases the roof life of the furnace. This may account for spottiness, gouges, etc. in the roofs. For such reasons it is unwise to use mortars containing more than 1 per cent alumina or any sodium silicate bond in a

Figure 8 — The per cent liquid at 3002 F in mixtures of $SiO_2 \cdot CaO \cdot Al_2O_3$ is shown by this sketch.



furnace wall which is largely silica, if the furnace operates at temperatures above 2750 F.

The reasons for the above lie in the fact that alumina and alkali flux so readily with silica. The development of a liquid within a refractory is its first breakdown during use, and is the advance guard of the failure assisting the fluxes which are contributed by the process during the normal operation of the furnace.

The extent of liquid development is readily shown by the following figures, which are easily derived from the equilibrium diagrams for lime, alumina and silica. Figure 7 is a section of the $CaO \cdot Al_2O_3 \cdot SiO_2$ equilibrium diagram, with two compositions plotted. Figure 8 shows the relation of the Al_2O_3 and liquid development in the brick. Figure 9 shows how this affects the load-bearing property of a brick. More important than the load-bearing property of the brick is its rate of wear. The solid portion of a refractory is more resistant to the

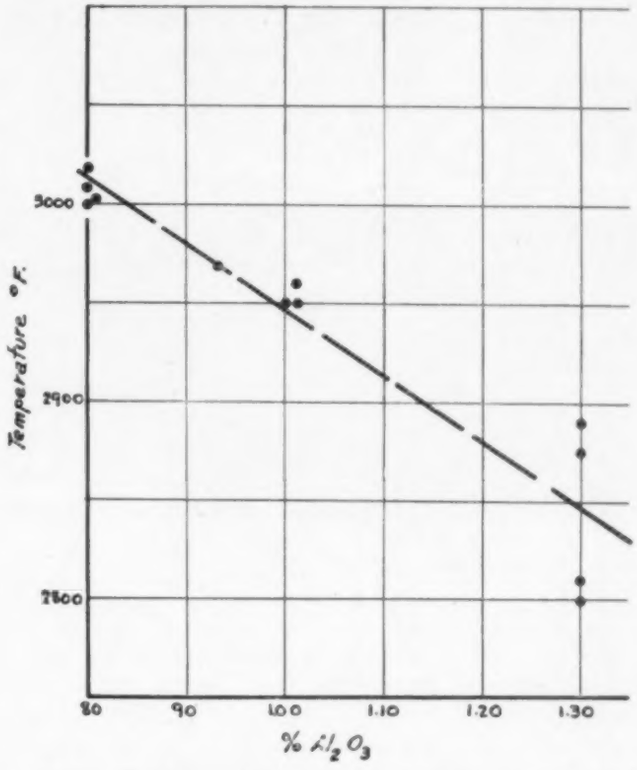
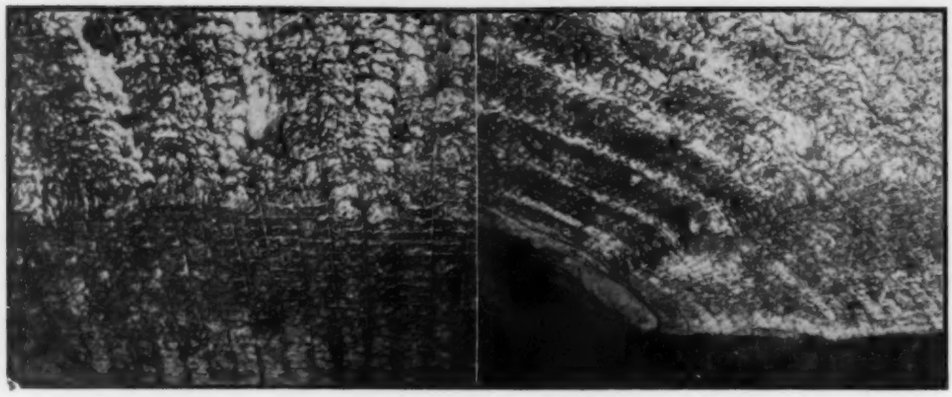


Figure 9 — The effect of Al_2O_3 on silica brick in the 50 lb hot load test is shown by a straight line curve.

solvent action of fluxes than the liquid portion. The rate of wear therefore bears direct relation to the rate of liquid development. It has been amply demonstrated that low-alumina brick wear longer than brick of higher alumina content. Figures 10 and 11 show how the rates of wear differ.

THE ALL-BASIC FURNACE

Where unusual labor conditions prevail which make it desirable to minimize repairs, particularly hot repairs, it may be profitable to resort to more expensive furnace construction to obtain continuous operation. Special conditions of operation such as the use of oxygen may also require special construction to withstand higher temperatures. The all-basic or the basic-end furnace may be required for such purposes. The most successful construction to date appears to be the basic-end furnace



Figures 10 and 11 — The lower alumina brick wears longer than that with the higher alumina content.

using a silica main roof. Through the use of this construction, considerable valuable time is saved from usual repair delays, and this goes a long way toward paying for the extra cost of basic materials. Larger uptakes result from the elimination of the big pier under the burners as this is not needed to support the rider walls.

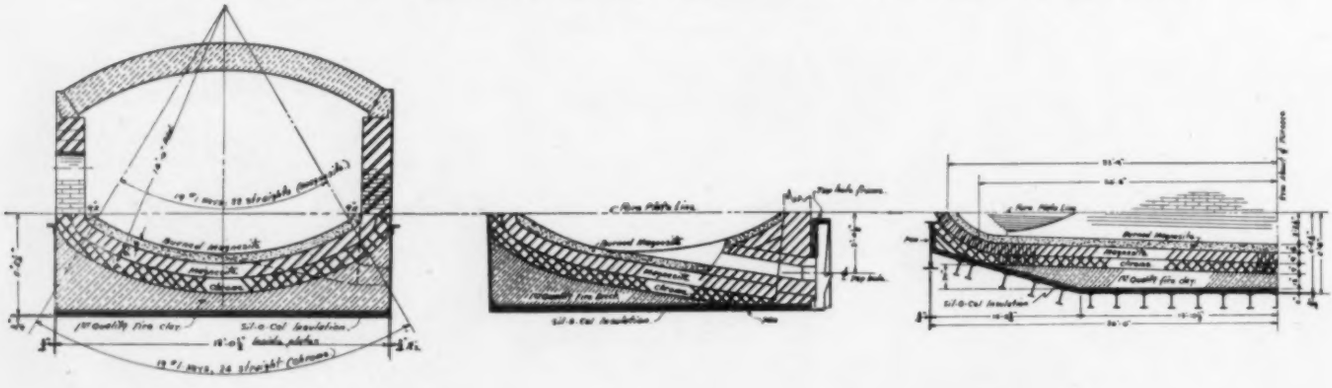
at high temperature than silica brick. Chrome-containing basic brick swell due to the absorption of iron oxide. This is referred to as "iron oxide bursting." Another weakness of these brick is the blotter-like action which causes an absorption into the hot face of iron oxide, lime and silica which may be available on the surface. This penetrates to a limited depth where the lower

Figures 12, 13, and 14 — Upon chilling, the all-basic brick may have a tendency to spall.

While basic brick have higher fusion points than silica brick, they have two inherent weaknesses which make it difficult for the refractories manufacturer to compete with silica under present operating conditions. Basic brick soften under load at high temperature due to the presence of small amounts of low temperature bonds and this is the primary reason for their having to be suspended. Basic brick tend to spall more readily

existing temperature causes it to freeze and prevent further penetration. When the roof is chilled, this impregnated face becomes rigid and tends to spall. See Figures 12, 13 and 14. While improvements are being made in refractories, changes are being made in furnace operation to improve conditions for these refractories. By such cooperation it is therefore believed that the economy of the all-basic furnace will be established.

Figures 15, 16, and 17 — Sections shown show trend of recent open hearth bottom design.



OPEN HEARTH BOTTOMS

Bottoms are now being made largely of brick construction lightly surfaced, or of brick construction with a heavy rammed working surface, or with a sintered magnesite surface. As the refractory which we seek for resistance to slag attack is magnesia, that refractory which can be applied in greatest density is the most likely to render best service. Densities of rammed, sintered and brick bottoms are shown below:

	Rammed	Sintered	Brick
Wt per cu ft installed	153-165 lb	193-210 lb	175 lb
Per cent MgO	65-78	70-74	85-92
Lb MgO per cu ft	99.5*	135-152	148-161

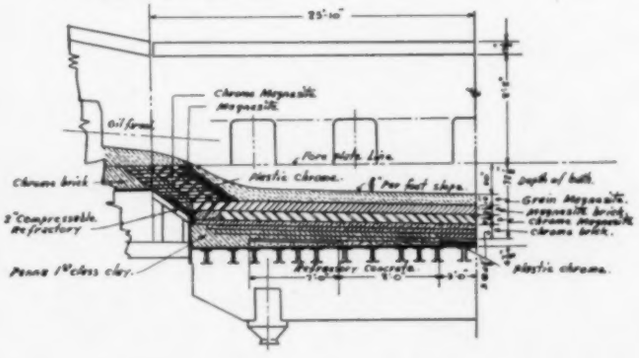
*As installed.

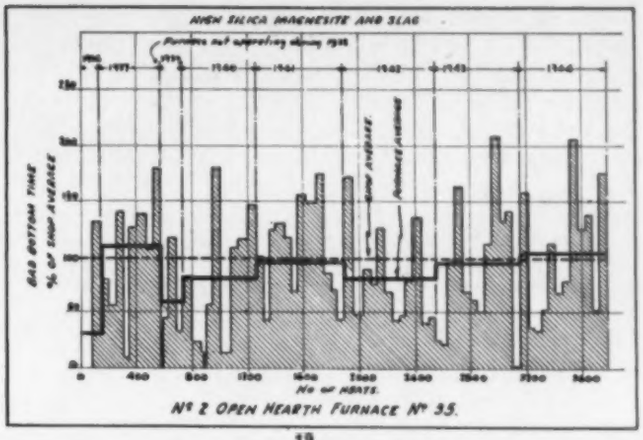
Iron oxide and the calcium ferrites are almost perfect solvents for most silicates. Magnesia is not as soluble in these as is dicalcium silicate. Dicalcium silicate and magnesia (periclase) are the principal constituents in open-hearth bottoms. Dicalcium silicate is a common constituent of slag. While this is true, dicalcium silicate is the transient constituent which dissolves most readily when the iron-oxide concentration becomes unusually high. Lime also disappears under such conditions. The refractoriness of magnesia is not seriously affected by iron oxide.

The mineralogy of open-hearth bottoms is a subject which could be dealt with extensively in a separate discourse. Further discussion therefore cannot be indulged in here. The trend in open-hearth bottom construction appears to be toward a large proportion of magnesite brick with a layer of magnesite sintered on top. While this is an outgrowth of the inverted arch bottom, the construction as a true arch has not been adhered to, although the use of brick has been retained. Figures 15, 16, 17 and 18 show some recent open-hearth bottom designs.

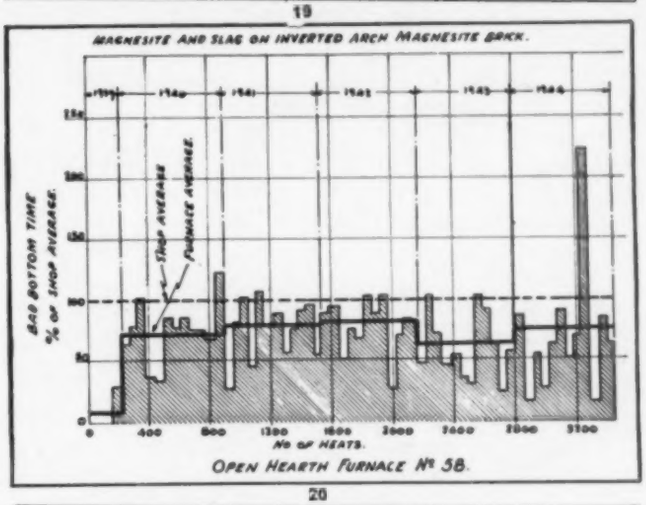
As in any other matter, it is essential to draw conclusions regarding open-hearth bottom performance from a suitable and adequate amount of facts. Charts such as are shown here (Figures 19, 20, 21 and 22) have been used to good advantage for this purpose. In each of them comparisons are made with the remainder of the shop in monthly periods. Regardless of what the shop average is, the furnace in question is compared with the shop percentagewise. An annual comparison can easily be made. Such charts show that some types of bottoms attain shop average bad bottom time within the first year, whereas others do not attain shop average

Figure 18 — The tilting furnace shown was converted to a stationary furnace.

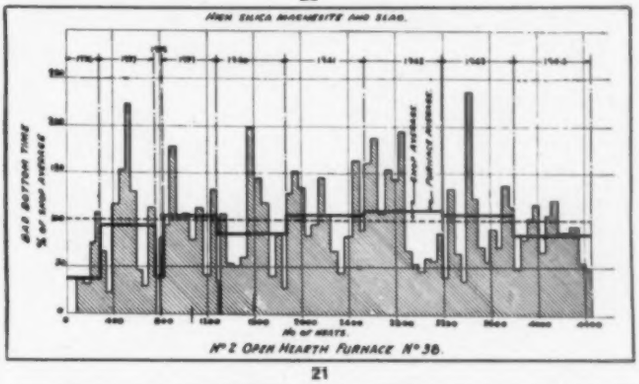



HIGH SILICA MAGNESITE AND SLAG
BAD BOTTOM TIME % OF SHOP AVERAGE
SHOP AVERAGE
FURNACE AVERAGE
No OF HEATS
Nº 2 OPEN HEARTH FURNACE Nº 35

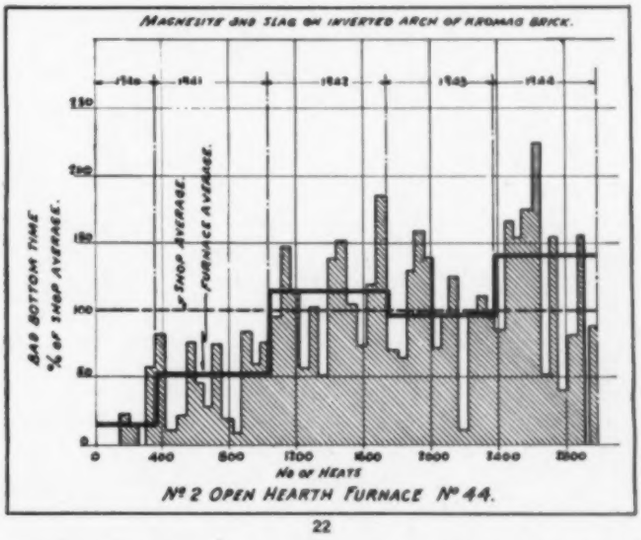
19


MAGNESITE AND SLAG ON INVERTED ARCH MAGNESITE BRICK
BAD BOTTOM TIME % OF SHOP AVERAGE
SHOP AVERAGE
FURNACE AVERAGE
No OF HEATS
OPEN HEARTH FURNACE Nº 38

20


HIGH SILICA MAGNESITE AND SLAG
BAD BOTTOM TIME % OF SHOP AVERAGE
SHOP AVERAGE
FURNACE AVERAGE
No OF HEATS
Nº 2 OPEN HEARTH FURNACE Nº 36

21


MAGNESITE AND SLAG ON INVERTED ARCH OF KROMAG BRICK
BAD BOTTOM TIME % OF SHOP AVERAGE
SHOP AVERAGE
FURNACE AVERAGE
No OF HEATS
Nº 2 OPEN HEARTH FURNACE Nº 44

22

Figures 19, 20, 21, and 22 — Charts such as these are valuable in studying furnace performance.

for two or three years. In no case are new bottoms so good that they recover the time required to install them by decreased bad bottom time. In other words, the time required to install new bottoms is generally more than the bad bottom time saved. There may be other factors which contribute to the decision to install new bottoms during busy times, but on the basis of studies using such data, one cannot recommend a new installation for only the time to be saved.

DISCUSSION

PRESENTED BY

A. T. HINCKLEY, Development Engineer, Oldbury Electric Chemical Company, Niagara Falls, New York

H. M. KRANER, Engineer of Research, Bethlehem Steel Company, Bethlehem, Pennsylvania

HOWARD P. DEVOE, Metallurgist, Blast Furnaces, Bethlehem Steel Company, Lackawanna, New York

W. D. MacDONNELL, No. 1 Open Hearth, Bethlehem Steel Company, Lackawanna, New York

P. F. KINYOUN, Combustion Engineer, Bethlehem Steel Company, Lackawanna, New York

S. M. SWAIN, c/o North American Refractories Company, 1012 National City Bank Building, Cleveland 14, Ohio

A. T. Hinckley: Has there been an attempt to eliminate the alumina oxide from the silica?

H. M. Kraner: Yes, considerable work is being done along this line. I do not think we have gone as far as is practicable but alumina is now generally lower than it was early in the war.

A. T. Hinckley: How is it done?

H. M. Kraner: This has been done largely by the proper selection of rock, and by the use and treatment of rock such as Sharon conglomerate. This rock occurs principally in eastern Ohio and northwest Pennsylvania.

H. P. Devoe: How many carbon hearth installations do we have in this country now?

H. M. Kraner: According to a recent article, I understand there are about twelve or fourteen.

Member: Has there been any up-to-date data on their performance?

H. M. Kraner: No, but there have been no complaints on their performance.

Member: Are there no different operating characteristics in the hearths?

H. M. Kraner: Nothing of that sort has been reported.

A. T. Hinckley: Do you happen to know how fine you have to grind a sample of brick in the case of let us say 60 per cent alumina brick as compared to the low silica brick?

H. M. Kraner: I believe a sample for chemical analysis must pass through a 100 mesh screen.

H. P. Devoe: What do they have in the carbon block hearths for cooling? Do they use the standard type of cooling?

H. M. Kraner: The standard type of cooling has been used up to this time. The carbon people would like to have us put in a furnace that is not water-cooled. This is an interesting point that was brought up by Dr. Chesters of The Steel Companies, Ltd., of Sheffield, a few months ago when he was here. He pointed out that in a carbon hearth the conductivity is high, therefore, the cooling is more effective than in the case of a clay brick hearth; the temperature is therefore lowered to a greater depth in the refractory wall and hence, instead of having, for example, a six-inch wall being chilled by the cooling system as in the case of clay brick, you actually have about three or four times that in the case of carbon. Incidentally Dr. Chesters said that they had about fifteen break-outs in their clay hearths in a single year, and they had to do something about it. Since they adopted carbon they have had very little trouble. He was very enthusiastic about the use of carbon in the hearth of a blast furnace.

W. D. MacDonnell: Has there been enough information accumulated on basic open hearth furnaces to determine whether they will eventually replace silica bricks?

H. M. Kraner: There have been quite a few basic furnaces installed. I do not suppose there have been enough of these to say definitely what they will do. Some people, of course, think they are the last word and are proceeding to put more of them in, but I think their economy remains to be proven.

W. D. MacDonnell: With the use of oxygen in the open hearth burners, how much increase in temperature do you have and what are its effects on silica roofs?

H. M. Kraner: This is in an experimental stage at the present time and some of the men who are working with it say they do not believe that oxygen will necessarily increase the temperature on the roof provided it is handled properly. By this they mean that if you continue to use oxygen through a period when you are pushing a furnace pretty hard, it would be apt to burn the roof. If however you use oxygen principally when the scrap is being melted, there is little danger of burning the roof as the charge at that time has a high capacity for absorbing heat.

P. F. Kinyoun: Mr. Kraner, is there generally sufficient raw material throughout the country so that the brick manufacturer can supply us with low alumina content brick?

H. M. Kraner: Yes there is, but keep in mind that each brick manufacturer owns a deposit which he would like to liquidate by making and selling brick. He has a financial situation to consider, and that might lead him to continue the use of the raw material which he has if he can find a market for the product which it will make.

S. M. Swain: I might add a little information on that point. Mr. Kraner is correct that most of the companies manufacturing silica brick have money invested in ganister lands. Each of these concerns is studying methods of cleaning the raw materials to get rid of as much of the alumina as possible. It is our hope that these resources may still be used and that we can give you the improved brick which you desire.

Program

ANNUAL SPRING CONFERENCE

ASSOCIATION OF IRON AND STEEL ENGINEERS

APRIL 26 - 27, 1948

HOTEL STATLER BUFFALO, NEW YORK

PROGRAM

MONDAY, APRIL 26

9:00 a.m. — Registration — Mezzanine Floor

9:15 a.m. — Technical Meeting — Chinese Room
Co-Chairmen:
Bruce B. Bargman
Superintendent, Fuel
Carnegie-Illinois Steel Corporation
Munhall, Pennsylvania

E. T. W. Bailey
Combustion Engineer
Steel Company of Canada, Limited
Hamilton, Ontario, Canada

"DEVELOPMENTS IN APPLICATIONS OF CONTROLLED ATMOSPHERES TO THE ANNEALING OF STEEL," by C. E. Peck, Manager, Industrial Heating Engineering, Westinghouse Electric Corporation, Meadville, Pennsylvania.

"HEAT TRANSMISSION IN STRIP-COIL ANNEALING," by J. D. Keller, Associated Engineers, Pittsburgh, Pennsylvania.

2:00 p.m. — Technical Meeting — Chinese Room

Co-Chairmen:
C. W. Barrett
Roll Engineer
Republic Steel Corporation
Chicago, Illinois

James N. Imel
Superintendent of Rolling Mills
Jones and Laughlin Steel Corporation
Pittsburgh, Pennsylvania.

"PASS DESIGN AND IMPROVED METHODS TO ELIMINATE SEAMS AND SURFACE DEFECTS," by J. A. Tischbein, General Foreman of No. 18 Rolling Mill, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania.

"LOOPING AND REPEATING ON MERCHANT MILLS," by W. J. Barry, Superintendent of Mills, Bethlehem Steel Company, Lebanon, Pennsylvania.

"THE ART OF ROLLING FLATS," by Charles P. Hammond, Superintendent of Rolling Mills, Atlas Steels, Limited, Welland, Canada.

2:00 p.m. — Technical Meeting — Fillmore Room and Parlor E

Co-Chairmen:
I. N. Tull
Electrical Superintendent
Republic Steel Corporation
Cleveland, Ohio

2:00 p.m. — (Continued)

R. W. Graham
Electrical Superintendent
Bethlehem Steel Company
Lackawanna, New York

"NON-CONTACTING X-RAY THICKNESS GAGES FOR METAL ROLLING MILLS," by Dr. C. W. Clapp, General Engineering and Consulting Laboratory, General Electric Company, and H. S. Maxwell, Steel Mill Division, General Electric Company.

"FOUR-HIGH REVERSING COLD STRIP MILL," by Lloyd L. Wilson, Engineering Consultant, Cold Metal Products Company, Youngstown, Ohio.

"ELECTRIC EQUIPMENT FOR FOUR-HIGH REVERSING COLD STRIP MILL," by J. S. Apperson III, General Electric Company.

7:00 p.m. — DINNER — Ball Room

Speaker: R. A. Gillies, Vice President, Steel Company of Canada, Ltd., Hamilton, Ontario, Canada.

TUESDAY, APRIL 27

9:00 a.m. — Technical Meeting — Chinese Room

Co-Chairmen:
F. S. Eckhardt
Chief Engineer
Bethlehem Steel Company
Lackawanna, New York

John F. Black
General Superintendent
Wickwire-Spencer Steel Division
Colorado Fuel and Iron Corporation
Buffalo, New York

"CENTRIFUGAL TUBULAR CASTINGS FOR INDUSTRY," by Earl M. Anger, Chief Metallurgist, Duraloy Company, Scottdale, Pennsylvania.

"POWER AND PRESSURE CALCULATIONS FOR ROLLING STRIP," by Frank P. Dahlstrom, Consultant, Arms-Franklin Corporation, Youngstown, Ohio.

1:00 p.m. — Inspection Trip
Bethlehem Steel Company
Lackawanna, New York

1948 ANNUAL SPRING CONFERENCE

DINNER SPEAKER

R. A. GILLIES
Vice President
Steel Company of Canada, Ltd.

CHAIRMEN

BRUCE B. BARGMAN

E. T. W. BAILEY

C. W. BARRETT

JAMES N. IMEL

I. N. TULL

R. W. GRAHAM

F. S. ECKHARDT

JOHN F. BLACK

AUTHORS

J. A. TISCHBEIN

EARL. M. ANGER

J. S. APPERSON, III

W. J. BARRY

F. P. DAHLSTROM

CHARLES P. HAMMOND

J. D. KELLER

LLOYD L. WILSON

C. E. PECK

Abstracts of Technical Papers

ANNUAL SPRING CONFERENCE
APRIL 26 - 27, 1948
BUFFALO, NEW YORK

"HEAT TRANSMISSION IN STRIP-COIL ANNEALING"

By J. D. Keller,
Associated Engineers,
Pittsburgh, Pennsylvania

▲ ANNEALING practice for coils was taken directly from that previously used for annealing of piled flat sheets, although for coils, this is the most difficult way to heat. For sheets, the conductivity for horizontal heat flow was good, but for radial conduction in coils, across the layers or wraps of the strip, the conductivity is very poor . . . not much greater than that of firebrick; while the thermal diffusivity, which governs the rate of temperature equalization within the coil, is only about half that of firebrick. Yet, ordinarily, five-sixths of the total heat is put into the coil radially, and only about one-sixth in the axial or vertical direction. The practice seems to have been determined solely by convenience of handling, without regard to the best method of heating.

Of the total apparent radial conductivity in strip coils, radiation between adjacent layers accounts for only about ⅛ of one per cent; actual metal-to-metal contact in microscopic spots, about 2 per cent; the balance, almost 98 per cent, is due to conduction through the films of gas between the layers. Coils are ordinarily wound 97 to 97½ per cent solid, hence only 3 to 2½ per cent is gas film; but this 3 per cent practically determines alone the radial conductivity. If the gas between the wraps could be replaced with pure hydrogen, the conductivity would be increased almost 7 times.

Heating by convector spacers should represent a very considerable improvement, since heat is put into the *ends* of the coils; but the bottleneck then is likely to be heat transfer to and from the circulated gas.

The trend is toward increasing the overall diameter of the coils and the piling height. But beyond a certain diameter, the disproportionately long time required (for equally good annealing) actually means a *decrease* of output per hour, per square foot of floor space. Also, the piling height is approaching the limit fixed by crane lift, while the weight of the annealing covers (equal in size to a small house) approaches the economical limit of crane capacity. Hence, the time appears near when a complete revolution in annealing practice will be called for. Once the possibility of a radical departure from present practice is conceded, many possible lines of development present themselves, of which it is not yet clear which is the best.

"DEVELOPMENTS IN APPLICATIONS OF CONTROLLED ATMOSPHERES TO THE ANNEALING OF STEEL"

By C. E. Peck, Manager, Industrial Heating Engineering,
Westinghouse Electric Corporation,
Meadville, Pennsylvania

▲ SEVERAL distinct types of commercially produced controlled atmospheres now in wide commercial use in steel annealing are discussed from various viewpoints. These viewpoints include the principal classifications of:

1. Equipment used to produce them.
2. Cost of production and relative operating cost.
3. Maintenance.
4. Specific applications.

Controlled atmosphere equipment and methods used for long and short cycle annealing of steels both low and high carbon and alloy types are discussed in the light of recent developments. Procedures and atmospheres for annealing without decarburization are described. Considerable attention is given to the production and application of non-explosive inert atmospheres.

Methods of purifying and drying the gases and control of quality of gas produced are discussed.

Operating practices, atmosphere consumption and distribution and various experiences and problems in various types of annealing furnaces are also discussed.

"LOOPING AND REPEATING ON MERCHANT MILLS"

By W. J. Barry, Superintendent of Mills
Bethlehem Steel Company,
Lebanon, Pennsylvania

▲ THIS article describes how hand-looping has been developed into completely mechanized repeating on the 10 in. mill at the Lebanon Plant of the Bethlehem Steel Company. This 12-stand mill was started in March 1926, with the purpose of supplying the bolt, nut, and specialty plant with the necessary tonnage, and with as great a range of sizes as possible. The range of this mill is from $\frac{31}{64}$ in. round to $1\frac{5}{8}$ in. round, and from $\frac{29}{64}$ in. to $1\frac{1}{4}$ in. square, with nut bars from $\frac{43}{64} \times \frac{33}{64}$ in. to $1\frac{15}{16} \times 1\frac{1}{8}$ in. The mill, as installed, consisted of six stands of 16 in. continuous roughing, numbered 1 to 6. Two 14 in. stands, numbered 7 and 8, are in line with the roughing. Two 12 in. stands are numbered 9 and 10, and two 10 in. stands are numbered 11 and 12. The bars were hand-looped from No. 8 stand on through to the finishing stand. Sizes to be hand-looped were $\frac{31}{64}$ to $1\frac{9}{32}$ in. rounds, $\frac{29}{64}$ to $1\frac{1}{8}$ in. squares, and nut bar flats from $\frac{63}{64} \times \frac{33}{64}$ in. to $1\frac{3}{16} \times \frac{47}{64}$ in.

It was physically impossible for the men to hand-loop the larger sizes on the mill, so necessity forced a change to mechanically repeating. The first mechanical repeater was set up in December, 1926. The other three repeaters were installed as soon as possible in 1927.

To obtain the increased tonnage made possible by the repeaters, it was necessary to mechanize the following operations: turning up the oval, diamond, or flat to enter the next pass; kicking the bar out of the repeater groove; opening and closing the finishing guides. These operations are now controlled by electric eyes.

With the mechanical repeaters on this mill, and the improvements that followed later, the tonnage rate per hour was increased from an average of 19 tons per hour for the year 1926, to 27 tons per hour for the year 1947.

"PASS DESIGN AND IMPROVED METHODS TO ELIMINATE SEAMS AND SURFACE DEFECTS"

By J. A. Tischbein, General Foreman of No. 18 Rolling Mill,
Jones and Laughlin Steel Corporation,
Pittsburgh, Pennsylvania

▲ THIS paper analyzes some methods and improvements which will help eliminate injurious seams and surface defects common to bar mills. The operation of the mill, of course, is not a cure-all for mistakes in the making of steel, and rolling requires the best materials which are available. Most seams are nothing more than cracks in the steel, possibly due to weak areas that may have been set up by stresses caused by either heavy drafts, improper rolling and handling techniques. These seams and imperfections can be eliminated partially by correct elongation and reduction, although initial defects in the process of making the steel cannot always be repaired. Proper size billets of the correct shape are essential so that the correct stock needed in breaking down the billet or bloom can be accomplished without encountering over-fills which will lap over and under-fills that will not fill out.

As one example in the improvement of surfaces, it was found that a three-inch round which in production originally required chipping of 50 to 100 per cent of the entire heat, after changing to a diamond and square groove pass layout, cracks and seams were hardly perceptible.

A few of the principles developed in this paper are:

1. If nothing is there to hold the metal, it will spread and rupture any weak portions thus causing cracks and seams.
2. The periphery of the bar should be covered by as much of the pass as possible.
3. Seams and cracks in the billet or bar cannot be welded together regardless of how hot the billet may be heated.
4. The bar or stock being reduced should be supported on all sides as far as possible.
5. Rolls must be set in line or seams and over-fills will develop that, in succeeding pass reductions, will lap over and form seams and cracks.
6. Good maintenance of rolls and equipment will eliminate trouble that will cause slivers and seams.
7. Billets that are heated slowly give a better bloom with which to work.

The advent of the new testing machines which locate defects not normally visible requires the best rolling practice available.

"THE ART OF ROLLING FLATS"

By Charles P. Hammond,
Superintendent of Rolling Mills,
Atlas Steels, Limited,
Welland, Canada

▲ THIS is the third of a series of papers on the art of rolling. The two previous papers were, "The Art of Rolling Rounds," and the "Art of Rolling Hexagons and Octagons." This paper will be an attempt to outline the various methods of rolling flats, including details as to practice, method, procedures and equipment used.

The outlined methods of the flat sections will consist of square edge flats produced by the tongue and groove method and the flat and edge method; near square flats produced by the use of fluted square and edging grooves, and also near squares rolled by the diagonal method.

There will be no intentional references made regarding the most desirable method or practice, since individual mill layouts and final end use of material rolled

is an important factor in deciding the roll pass design and rolling technique.

The processing of the various grades is an important factor and most mills prepare the layouts to suit these conditions. It is necessary for the roller to apply considerable rolling technique and resourcefulness on almost any mill that is equipped to cover a wide range of flat sizes, as there are usually a number of sizes that are made successfully without a special edging groove. For example, the edging may be designed and turned with grooves by increments of $\frac{1}{32}$nds and a small order of flats is required in $\frac{1}{64}$ths, for instance $\frac{25}{64}$ths in thickness. Depending on the grade and size of the order, the size can be produced thus saving roll changing cost and the cost of having rolls by increments of $\frac{1}{64}$ths.

Any required size of flat requires a certain amount of stock, whether it is produced with two, three or four edgings. Conditions of the mills, such as speeds, roll diameters, grades to be produced, size of orders and final end use are a determining factor when making a decision regarding a flat layout.

High speed, stainless and tool steels may require a three edging or even four edging procedure, depending on the speed of the mill and size of the orders. Mills rolling machinery grades may set up with two-edging or three, depending on the mill conditions.

Three or four edging, when rolling the highly alloyed grade, reduces the difficulty of obtaining sharp corners and assists the bar in entering, as heavy drafts on these do create an entering problem due to the rolls not biting the bar as readily as the low carbon or machinery grades. Also, the extra edging passes eliminate the heavy draft and has less tendency to cause surface defects such as collar marks, wrinkles, etc.

"NON-CONTACTING X-RAY THICKNESS GAGES FOR METAL ROLLING MILLS"

By Dr. C. W. Clapp,

General Engineering and Consulting Laboratory,

General Electric Company

and

H. S. Maxwell,

Steel Mill Division,

General Electric Company

▲ A means of continuously gaging the thickness of hot rolled strip during production has been needed since the advent of continuous rolling mills. With hand gaging, a modern hot strip mill will frequently roll several slabs into off-gage strip, with resulting expense of re-application, before the first strip to be coiled can be gaged with hand micrometers. "One-spot" gaging is inherently inadequate because of the many factors that can affect the thickness of strip while it is being rolled.

An X-ray thickness gage now available permits continuous production of on-gage strip by continuously and accurately indicating the deviation of the thickness of the strip from the required thickness as it leaves the last roll stand. It becomes a simple matter for an operator to hold the thickness of the strip within close tolerances by observing the trend of deviation and making progressive screwdown adjustments.

A need for a non-contacting electrical gage for cold strip mills has developed during recent years as mile-a-minute speeds have been approached and exceeded.

The paper includes descriptions of hot mill and cold mill gages in service, their scheme of operation, performance, and some of the problems of design. With this background information, factors to be considered in the application, installation, operation and maintenance of X-ray thickness gages are discussed.

"FOUR-HIGH REVERSING COLD STRIP MILL"

By Lloyd L. Wilson, Engineering Consultant,

Cold Metal Products Company,

Youngstown, Ohio

▲ FOUR-high reversing cold strip mills are not new. M. D. Stone, of United Engineering Company, places the first of these in the early 1920's. Many different reversing mills have been developed and tried out since that time.

The all-pull mill used small work rolls and was intended for light gages. Small work rolls, with their small arc of contact, tension and anti-friction backing rolls, permitted unusual reductions on hard materials and reduced overall size of equipment. Other contemporary mills used a combination of pull and drive delivered through the work rolls. All of these mills were deficient in various respects.

What was needed by industry was an all-purpose mill, to meet today's demand for higher production and lower costs. Cold Metal Products Company determined to overcome the deficiencies of the several varieties of 4-high reversing mills.

To accomplish this it was decided to try driving the back-up rolls, in conjunction with relatively high tension. A small mill was built, 10 inches wide, incorporating this idea. This mill has now been in operation for some time. It was built for finishing light gages of hard materials and, although underpowered, has proved beyond a doubt that, with driven back-up rolls augmented by the tension, reductions can be made on 18-8 stainless, 3.5 per cent silicon and 1.25 per cent carbon steel approaching those considered normal for low carbon steels on the now conventional 4-high mill. Trial reductions of up to 50 per cent were made on these steels, without slippage between the rolls. Production is 3 to 10 times that of a similar size mill of the all-pull type when rolling the thinner gages. High silicon steel has been rolled from 0.025 to 0.010 and low carbon from 0.020 to 0.006 in three passes.

With such favorable results it was decided to build a larger mill for general use. This mill is not yet built, nor completely designed, but has progressed far enough to permit a general description:

Reductions up to 40 to 50 per cent are anticipated on soft steels, using 6 in. diameter work rolls, power driven 34½ in. back-up rolls, a top mill speed of 1800 fpm, on strip up to 26 in. wide. Screwdowns are of the wedge type; bearings of the double row radial design; housings have a window opening of 35 in. and a cross sectional post area of about 250 square inches.

Cooling facilities are standard, with mineral oil as a coolant, though soluble oil can be used when required. Tension reels are bottom coiling, supported on both ends, and will take coils up to 400 lb per inch of width. All conventional controls are provided.

As planned this mill will suit very well for all breakdown operations, but for rolling to the intermediate and to the final light gages should be ideal.

"ELECTRIC EQUIPMENT FOR FOUR-HIGH REVERSING COLD STRIP MILL"

By J. S. Apperson, III,
General Electric Company

▲ THE paper describes the electrical equipment used on the original small mill now in service at the Cold Metal Products Company. The results of power readings taken on this mill are presented in the form of readings and curves with simple formulae to show how these data are converted into rolling power calculations.

The power requirements determined in this way are projected to show the selection of electrical equipment for use with the proposed new mill. With the electrical equipment so determined, a brief description of the proper layout of the electrical equipment is given. Comments on specific points brought to light from the test are also included.

"CENTRIFUGAL TUBULAR CASTINGS FOR INDUSTRY"

By Earl M. Anger,
Chief Metallurgist,
Duraloy Company,
Scottdale, Pennsylvania

▲ CENTRIFUGAL tubular castings are needed for many purposes, where, at present it is almost impossible or only with long delay to get special shapes, odd diameters with various wall thicknesses, or when compositions of special analysis are desired.

The manufacture of castings of tubular sections is described from the furnace equipment, specification and composition of mold material, set up of molds and method of pouring and cooling of the cast tubular sections. Some of the data of the operation of cooling from a liquid to a solidly formed tubular section are noted. The results of centrifugal action on these sections are shown on a slide of macroetched section. The grain structure of the alloy in this section is shown to start with each grain unbroken from the outer diameter to the bore and is directly opposite in contrast to the well-known static structure.

Moderate explanation of the production of material in tube form and some results of production of sheet from centrifugal tubular sections are given.

The experiments were carried out with some of the super alloys which the mills have had considerable trouble to pierce.

It is not claimed that large production could be made by the centrifugal process. Many of the alloys could be successfully produced which could not be produced otherwise. Physical properties are given of centrifugally produced tubular sections and the composition of many alloys that are under constant production.

"POWER AND PRESSURE CALCULATIONS FOR ROLLING STRIP"

By Frank P. Dahlstrom, Consultant,
Arms Franklin Corporation,
Youngstown, Ohio

▲ IN the conventional formulas the power required to roll strip is based upon the product of the torque at the center of pressure area in the pass and the velocity of compression at that point.

In practice, the pass horsepower is often computed from the equivalent torque at the outside diameter of the rolls and the delivery speed of the strip.

The paper shows that the power required to actually deform the metal is determined, not from the delivery speed, but from a speed which is somewhat less than the average of the entering and delivery speeds of the strip. This "hyperbolic" average speed is shown to be dependent solely upon the percentage reduction in the pass. When this average is used, the work required for an overall reduction is found to be independent of the number of intermediate passes, and the basic law of the conservation of energy is not violated.

The difference between the delivery speed and the "hyperbolic" average is the true slip velocity. Knowing this velocity, the overall coefficient of friction can be computed from pressure and power readings, etc., taken in the field. Likewise, knowing the friction coefficient, the paper shows how to compute the frictional losses in the pass. By knowing the true deformation power and friction losses in the pass, the efficiency of the rolling process can be predicted which should help in studying the effect of large and small work rolls.

Previous work on the build up of rolling pressure due to "skin" friction and roll flattening is reviewed. The paper concludes with calculations, forms, and methods of using them for computing the rolling pressures, powers and efficiency of the rolling process for both hot and cold rolling.

Factors in the Operation

OF A MANNESMANN PIERCING MILL

. . . . the piercing mill must be so set that the metal does not break ahead of the plug, otherwise bad inside surface will appear on the finished tube . . . .

By H. R. McLAREN, Assistant General Superintendent
Steel and Tube Division
The Timken Roller Bearing Company
Canton, Ohio

▲ THIS discussion of the piercing operation is confined to piercing on what is called the Mannesmann piercing mill. This is by no means the only type of mill on which piercing is done. The seamless industry also uses the disc and cone mills, but the barrel type is by far the most used, both in number of units in use and tonnage produced thereon.

The history of the development of the Mannesmann piercing process is interesting. The firm of A. Mannesmann, a file manufacturing concern in Germany, had purchased their semi-finished stock from England. Then, in the first part of the eighties, they built a crucible furnace to make their own stock.

This metal was forged on steam hammers into long round bars. Following the English practice, these bars were then polished in a reeling machine, an apparatus having two diagonally arranged rolls. When the bars were cut into short lengths, a high percentage of waste was encountered due to small internal cracks.

This experimental work of making the file steel was done by Reinhard and Max Mannesmann, and in studying the cause of the internal cracks, they came to the conclusion that it was a function of skew rolling. With this idea in mind, they started to try to produce a hollow body without a mandrel using the skew rolling mill. This was in the year 1884. They were able to produce tubes but the insides were very rough and uneven. The inventors then introduced a mandrel in the opposite direction to the travel of the tube for the purpose of ironing out the rough interior. At this stage of the experiments, the first patent was taken out on January 27, 1885. More complete patents were taken out in June, 1886.

From this time forward, the Europeans tried to produce the finished tubes in one operation in the piercing unit. Being unsuccessful in this, they invented another type of mill called the Pilger mill which took a heavy walled pierced shell and produced a relatively light walled finished tube. This, then removed the burden of work from the piercing unit, and as a consequence the German development of the art of piercing was retarded until the late thirties.

One of the original operators of the Mannesmann mills in England was R. C. Stiefel. Mr. Stiefel came to America in the nineties and took out piercing patents and installed several units. He designed his mills with a rolling mill following the piercing mill. With this method, the piercing mill produced a rough shell of slightly heavier wall than the finished tube and this shell was then rolled to a lighter wall in the rolling mill. These type units were later improved and became known as the automatic mills.

THEORY OF PIERCING

The Mannesmann piercing mill consists of two double conic rolls, each roll set at an angle to the work piece but with the centerline of their shafts lying in parallel planes. See Figure 1. Both rolls turn in the same direction, thus driving the work piece in the opposite direction.

The operation of the mill is as follows: A piece of steel is pushed into the mill until the rolls engage it and start it spinning. Since the rolls are at an angle to the work piece, one component of the force of the roll is in a longitudinal direction and this pulls the steel forward. As the steel travels along the roll, it meets the plug which is set some distance back from the first point of contact; the metal immediately starts to flow along both sides of the plug forming a tube.

What actually happens is that the plug acts like an

Presented before AISE Annual Convention, Pittsburgh, Pennsylvania, September 22, 1947

internal roll and we have two sheet rolling rolls, one on each side of the plug, between the plug and the roll. At the start, very small increments are rolled in a longitudinal direction, but as these increments increase in length, we have further pull from the longitudinal component of the force between the plug and roll and this acts to bring still more metal along the roll to the outlet.

As the metal is rolled between the plug and the roll, it tends to elongate in a transverse direction to the work piece and this produces a larger inside than the plug diameter. This action pulls the metal away from the plug both in the top and bottom part of the mill while the metal is tight to the plug on the two sides. This permits the plug to cool more than would be the case if the hot metal was tight on the plug, and this gives better plug life.

In the original experiments of polishing solid bars on an oblique roll mill, internal ruptures appeared, and later on, tubes were produced by the same action. This action is always present in the piercing mill, but the mill must be set correctly so that the metal does not break ahead of the plug. If the metal does break, no subsequent operation will remove the tears so produced, and bad inside surface will appear when the tube is finished. This has been proven by stopping billets in the mill and cutting them open for examination, both when making good tubes and bad tubes.

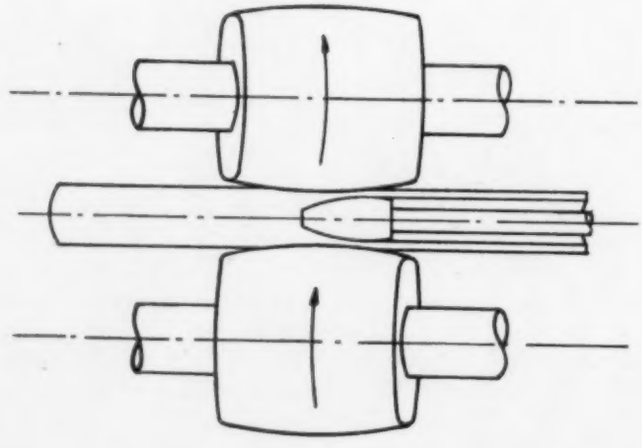
The factors which contribute to the rupture in the piercing mill are as follows:

1. Too much cross rolling caused by too small a feed angle or too much draft, or by too much roll contact.
2. Rolling the steel with too little ductility due to not using the correct temperature.

PREPARATION OF THE STEEL

It is essential that the steel be of the best quality when used for making seamless tubes. The only place that the internal quality can be controlled is in the melt shop, but the surface can be improved by conditioning.

Figure 1 — Both rolls on the Mannesmann piercing mill turn in the same direction, and since each one is set at an angle to the work piece, the force pulls the billet over the mandrel.



The conditioning practice varies in different mills, but I will attempt to arrive at a good average practice:

1. Condition blooms.
   a. Pickle and machine chip.
   b. Pickle and scarf or grind.
2. Condition billets.
   a. If blooms are well conditioned, hand chip, grind, or scarf hot rolled billets on standard material.
   b. Pickle and condition by chipping or grinding on special material.
3. Turn surface completely on stainless types.

CENTERING BILLETS

It is necessary to make a center in the billet before piercing so that the plug will start in the center and thus keep eccentricity at a minimum. There are various methods of doing this centering, as follows:

1. Center punch hot at bar mill. This is the most satisfactory if the bar mill can be so equipped.
2. Center punch hot between the billet furnace and piercing mill. This method is almost as good as centering at the bar mill, only heat should not be lost at this place.
3. Torch center.
   a. Cold billets.
      This causes cracking in certain high carbon or alloy types.
   b. Hot billets.
      This can be done between the billet furnace and piercing mill, but punching is much cheaper.
4. Drill centering.

   This is the most expensive centering but is used under certain conditions when none of the other types seem to fill the bill. In fact, the original centering was done by drilling. Where steel is purchased in long bars and the mill is not equipped to punch after leaving the billet furnace, there is quite a lot of drilling done.

   On expensive steels such as the stainless grades, drilling is used almost 100 per cent.

HEATING

There are two types of furnaces used for heating seamless rounds; the longitudinal sloping hearth furnace in which the billets are rolled forward by hand, and the rotary furnace in which the hearth rotates and carries the billets through.

The longitudinal furnaces have been in use for years. They are made with one, two, or three heating zones. A rate of heating of 30 minutes per inch of diameter is generally used. The disadvantage of this type furnace is the cold hearth on which the steel rolls down to the hot zone. Often this hearth is not up to steel temperature until the steel is two-thirds through the furnace. This necessitates short and frequent rolls to satisfactorily heat the steel.

The rotary furnace, which just came into the picture in 1940, offers quite an improvement in the heating of seamless rounds. The steel is charged on a hot hearth and does not require rolling over to be heated uni-

formly. It is conveyed through the various zones which are set at the required temperatures by the rotating hearth. By setting up the correct heating cycle and the rate of travel through the furnace, the operation can be almost automatic. In addition, the time of heating can be maintained at 20 minutes per inch of diameter. Scale formed is about one-half that obtained on the roll-down furnaces.

There are various methods of arriving at the temperature of discharge, but I believe the method most often used is to soak out the steel at some low temperature and to rapidly raise the temperature to the discharge temperature, and also, the furnace should not be carried above the discharge temperature specified. It is possible to take more tonnage out of a furnace by overrunning the discharge temperature, but the possible bad effects of rolling overheated steel, mill trouble from soft mushy surfaces, and furnace maintenance, all point to not overheating the furnace and trying to catch the steel on the way up to the furnace temperature.

The temperature used in piercing seamless steel varies from 1780 F to 2300 F, depending on steel specification, and there is no set formula for what temperature to use. A very good aid is the hot twist test to determine maximum ductility, and from this subtract an amount equal to the temperature built up during piercing. This build-up varies with speed of piercing, section produced, and strength of material so some experimental work must be done to find this factor for various mills.

GUIDING

The guiding during piercing is one of the most important points by which the quality of the finished product is controlled. The guiding should be divided into units as follows:

1. Inlet guides.
2. Mill guides — top and bottom shoes.
3. Outlet guides — tube and bar.

Before discussing the various phases of guiding, I want to mention the fundamental axiom for all guiding, and that is that the centerline of the work piece shall remain a straight line during all movement from solid to tube during piercing.

The inlet guides in use consist of an upper and lower guide, and a guide barrel extending into the mill. The bottom guides are changeable for various sizes, and adjustable so that the piece of steel can be lined up with the working centerline. The top guide can be changed and opens to admit the piece of steel. There are several mechanical inlet guides in use, both roller and fixed V type. The big advantage of the newer mechanical inlet guide is time saving on mill changes.

Next to the inlet trough is the inlet barrel which extends through the mill housing to the rolls. The function of this guide is to prevent whipping of the steel after it leaves the inlet trough. This guide should be set with the bottom of the guide located so that the centerline of the steel still stays on the working center of the mill. All clearance is taken between the top of the steel and the top of the guide.

We next come to the mill guide shoes of which there are two, one on top and one on the bottom. A standard design of the shoe is an impossibility as various operators desire to use various designs but there are certain fundamental facts that must be adhered to:

1. The correct shoe design must be made for the steel size used and the tube produced.
2. The bottom shoe must be designed so that the centerline of the work piece is at all times on the working centerline.
3. Due to the fact that shoes are a fast depreciating item, they should be as short and thin as possible for the particular job. They definitely can be 2 to 3 in. shorter than the roll face.

From the guide shoes, the tube next passes through the outlet guides. These consist of top and bottom guides, the top guides opening to eject the finished tube. The bottom guides are set so that the bottom wearing surface of the guide is one-half the tube diameter below the working center of the mill. This permits the tube centerline to remain on the working centerline of the mill.

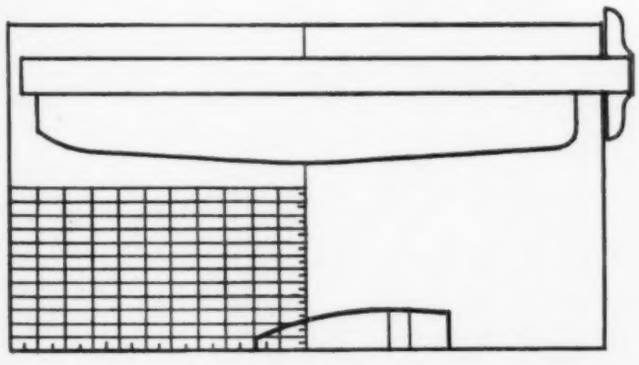
All clearance between the guide and tube is taken on the top. By working these guides as mentioned, the whip is taken out of the tube since we are keeping the steel at all times on the working centerline, and since the working centerline is below the mill centerline, both the mill forces and gravity are working in the same direction.

There are roller outlet guides in use on a few mills, and these are very satisfactory if properly designed so that there is no play developed in them as they grow older. The roller guides, being adjustable for various sizes, can be set with less clearance than the fixed guides.

The bar guides are of several designs, all of which consist of some method of holding the bar until the piece of steel reaches the guide and then opening to allow the tube to pass through it. With the use of these bar guides, it is essential that the centerline of the bar be kept on the working centerline of the mill. This is contrary to the old practice where bar guides were not used and the bar was set ½ to ¾ in. higher at the thrust block end. This would cause a downward bow to the bar which eliminated whip by causing the tube to ride the bottom guide tightly.

The present method of setting all guides so that the work piece always remains on the working centerline is

Figure 2—A set-up board is used in order to rapidly determine the correct plug size which should be used.



better practice and gives better results than the older method.

ROLLS

Piercer rolls are dressed with a double conic surface. The large part of the cones meet at the center or back of the center of the roll. The angle created by the joint of the two conics is machined off either in a flat surface or a tangent radius. The radius is the best as it marks the surface of the tube less.

The roll-face angles in use at the present time are approximately 3½ degrees. This is quite a change from the 7½ to 8½ degrees used 15 to 20 years ago. The advantage of the smaller pass angles is reduced draft with the same length of contact.

Roll-face length varies from 16 to 30 in. and this factor is the reason for the necessity of various designed piercer plugs since the tube must be produced in various lengths of roll, and this means various rates of reduction on different mills. Some mills in order to decrease the rate of reduction have offset the joint between the inlet and the outlet conic 2 to 4 in. back toward the inlet. This then gives a longer outlet and a slower rate of reduction or greater diameter expansion.

The rolls are operated at various feed angles from 6 to 12 degrees and this factor creates a heavy end thrust on the roll bearings. When brass bearings are used, the thrust wears off the brass on the thrust collar and gives endwise play in the roll. This is very bad in the case of the roll which is high on the inlet end. The force of the roll bringing the tube through the mill is backward, and thus this force pushes the roll further up if there is play in the brasses. The roll stays up until the backward force is less than the weight of the roll and spindle, at which time the roll drops forward causing a sticker. This can only be corrected by installing roller bearings on the rolls.

The speed used on the various piercing mills varies from 50 to 150 rpm while roll diameters vary from 18 to 48 in. The most general roll speed in feet per minute varies from 700 to 950 feet. These speeds are all right for standard tubes, but for special high alloy steels and to be able to correct stickers, a d-c motor giving a minimum surface roll speed of 400 to 450 feet per minute is very helpful.

The power required for piercing can best be expressed in figures of kws per cubic inch of metal displaced. I have obtained some such data and find that it varies from 7 kws per cubic inch displaced to 25 kws. Studying the data, I find that ligher walls of the same material cause higher power readings as do various analysis of higher strength material. This is as we would expect it to be.

PIERCER POINTS

Piercer points are in the same category as guide shoes as far as non-uniformity of design is concerned. There is more excuse for various designs of piercer points than shoes, because the various lengths of the rolls in different mills require different rates of reduction from solid to tube in producing the same tube size.

The plug surface may be divided into two portions: First, the working section with which the piercing is accomplished; and the reeling section which smooths out the inside somewhat and helps pull the last end of the billet out of the mill.

The working section can have an angular or radius-conic surface, both of which have been used successfully; though at present, the radius surface is the most popular. Theoretically, the radius surface is correct, but there are so many variables present in a piercing mill that the contour of the plug is only a small part in correct piercing. The other variables such as draft, lead, roll surface, working length of plug and piercing temperature, etc., all contribute to good or bad piercing.

The most important point in plug design is the length of the working surface. This determines the rate of reduction from solid to tube. This length is controlled by the length of the outlet of the rolls as the tube must be produced in the mill, not out of it. There should be a constant change in length with plug size change. One can plot a graph with plug size as abscissa and working length as ordinate and by charting two plug lengths, draw a straight line between them and then pick off any other plug length.

The second part of the plug, the reeling section, which is a section parallel to the roll face and at least as long as 1½ feed lengths, is used for smoothing out the pierced blank but more important is used to bring the back end of light wall tubes out of the mill without stickers. This section is not necessary on heavy or medium wall piercing and by leaving it off, a longer working surface can be made on the plug with a corresponding lower rate of reduction.

Plugs are made of various material: The oldest type, and I believe the most used, is low carbon chrome nickel molybdenum steel. Other analysis in use are a copper cobalt analysis and a 7 per cent molybdenum, 1½ per cent chrome type.

SETTING THE MILL

After having taken care of the details of the various

Figure 3 — 18 in. Mannesmann piercing mill.

parts of the piercing mill, there still remains the problem of putting them together in such a way as to produce a satisfactory tube. This function is called setting the mills, and involves the following points:

1. Setting the guides.
2. Setting the rolls.
3. Setting the plug.

We have covered the setting of the guides in the section on guides.

The setting of the rolls involves an angle of feed, and the draft or pull on the steel. The angles of feed in use are 6-8-10 degrees and in a few cases, 12 degrees. Of these angles, the 8 and 10 degrees are the most used. The determination of the angle to use is controlled by various factors, such as type of steel, and section being produced. The larger the angle used, the less roll contact there is for a given draft and consequently, the greater slippage.

The rupture forces of the piercing operation are much more evident with small feed angles than with large angles, but the piece of steel feeds much smoother through the mill with the small angle.

The general use of feed angles can be expressed by the following table:

6 degrees — Used for correction of slippage troubles which occur after a long mill delay. Can be used for piercing exceptionally heavy walls.

8 degrees — Used for heavy and medium heavy walls.

10 degrees — Used for medium and light walls and for sensitive piercing steels.

12 degrees — Used only on certain mills to obtain high production on relatively easy piercing steels. Could be used more often but most mills are not equipped to obtain this large an angle of feed.

The next point of roll setting is the draft or pull of the rolls on the steel. This pull or draft is expressed mathematically by subtracting the smallest section between the rolls, called the gorge, from the steel diameter. The amount of draft used determines the roll contact ahead of the gorge.

Figure 4 — Piercing of the billet has been just about completed on this 36 in. Mannesmann mill. The mandrel will next be withdrawn and the tube rolled off to the left.

For a given roll-face angle, the different billet sizes require different amounts of roll contact to force the steel over the plug. The larger the billet size, the longer roll contact necessary to feed the steel through the mill. The section being produced and type of steel require slightly different amounts of contact to pull the same size billet through the mill, so any given size of billet has a range of maximum and minimum draft to be used. The maximum and minimum varies from $\frac{1}{16}$ of an inch on small billets to $\frac{1}{8}$ of an inch on large billets. The normal draft varies from the smallest to largest billet.

The best way to set up the draft to use for various steel diameters is to determine, empirically, the draft to use for two steel sizes and plot a curve using steel size as abscissa and draft as ordinate. Using the draft shown from this curve, determine the necessary variation from it on the different sections and steels that are to be pierced.

The last point to settle is the setting of the plug. This involves quite a lot of variables, though for any one mill these can be evaluated quickly, but such evaluation is useless on another mill. The variable factors are as follows:

1. Plug design.
2. Expansion necessary on the billet being used.
3. Conditions of surface of rolls.
4. Roll angles being used.
5. Feed angles being used.
6. Steel diameter being pierced.
7. Section being produced.

The important point to remember is that for a given draft, there is a definite length of roll contact, and with this roll contact, there is a minimum length between the first point of contact of the roll and the steel and the nose of the plug, which will permit the steel to feed forward. Also, there is a maximum length for the contact between the billet and plug in order to prevent rupture of the steel ahead of the plug.

This complicated description of the plug setting is handled very simply by the mill men by setting the draft and picking a plug setting from experience. If the steel does not come in, more draft is used for that billet, then the mill is reset with the correct draft and the plug is drawn back a small amount.

In the determination of the plug size to use, a setup board is used. See Figure 2. This board consists of a drawing board having a vertical centerline on it where the gorge of the roll is located. The inlet end is ruled off in fractions of an inch steps, actual size in the horizontal direction and $\frac{1}{2}$ size in the vertical direction. A sliding square having the exact roll contour on the bottom side is used to represent the roll. Templets cut to the shape of the plug on one side and straight on the other side are used.

The sliding square is set to the gorge desired to use for the particular steel to be run. A plug templet of the approximate size is chosen and placed on the drawing board with the straight side along the bottom of the board which represents the centerline of the mill. The nose of the plug is set a distance away from the steel as is desired based on previous knowledge. Then, the smallest dimension between the plug and sliding square is measured. This represents the wall this plug will produce. Following the above practice, we determine the correct plug to produce the desired wall.

DISCUSSION

PRESENTED BY

NEWELL HAMILTON, Superintendent, Steel Plant, Babcock & Wilcox Tube Company, Beaver Falls, Pennsylvania

H. R. McLAREN, Assistant General Superintendent, Steel and Tube Division, The Timken Roller Bearing Company, Canton, Ohio

WILLIAM RODDER, Chief Engineer, Aetna-Standard Engineering Company, Youngstown, Ohio

M. S. GETTIG, Superintendent, Seamless Tube Mill, Youngstown, Ohio

A. G. ERICSON, Chief Engineer, Homestead Works, Carnegie-Illinois Steel Corporation, Munhall, Pennsylvania

W. TRINKS, Associated Engineers, Pittsburgh, Pennsylvania

S. FINDLATER, Development Engineer, National Tube Company, Pittsburgh, Pennsylvania

S. WILLIAM STOUFFER, Construction Engineer, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania

Newell Hamilton: There is one point that I would like to bring up and that is the question of guides. Quite frequently mill men are inclined to think of guides on a piercing mill in the same manner as they think of guides on a bar mill, and they certainly do not serve the same purpose. A piercing mill guide actually confines the steel and serves as one of the elements of dimensional control, which is something that it does not normally do in a bar mill operation. If you did not have that piercing mill guide, a large loop would develop in this 3-high mill, that we have been discussing with the piercer rolls and the piercing point. The guides actually keep that loop from developing and determine the periphery of the finished work piece.

Another feature of a piercing mill that I think should be mentioned is that about 90 per cent of the difficulty with it is brought about by the fact that we try to do too many things with the same mill. Theoretically, there is only one roll diameter, one roll contour, and one plug size to produce the ideal pierced hollow, and I say that because of the fact that a lot of the difficulties are brought about by differences in peripheral speed between the work piece and piercer rolls and shoes and other confining elements.

I do not think that this is fully realized, particularly by some of the men who are trying to cover a wide range of sizes with the same mill equipment.

H. R. McLaren: Mr. Hamilton is absolutely correct that the piercing mill guides do control the rolling operation through the piercing mill, and that is the reason I stressed so strongly the fact that we do have to maintain a straight line through the working center line of the mill, all the time during the piercing operation from solid to tube.

William Rodder: I would like to mention one more feature of a piercing mill. I think it should be designed not for strength alone but with plenty of rigidity to dampen vibration. I am quite sure this also will improve the product.

The designers recognize the importance of guiding of billet, tube and bars, and are continually striving to improve it; also the importance of changing guiding equipment quickly for size change. Hydraulic jacks with self-contained oil hydraulic units instead of nuts, keys and sledge hammers, are being adopted. The mandrel guides are being designed to center and guide bars of various diameters without requiring any adjustment.

In regard to the size of piercer roll diameter, I would like to ask Mr. McLaren if in his experience he found a difference in product by using smaller or larger diameter rolls; that is, whether he thinks that the relation between roll diameter and billet diameter has any effect on the concentricity. Looking at it from the point of view of rigidity, roll life, or bearing life, the larger roll, of course, would be the most desirable.

H. R. McLaren: There is much argument on large rolls versus small rolls. We happen to have pretty small rolls and also medium large rolls. I think 18 inches is the smallest we use. We use a 36 in. roll in two of our mills. However, I will say it becomes more a matter of preference. I do believe that there is possibly an extreme range both top and bottom where you will notice a difference, but in that range from 18 inches to 36 inches we do not, I will have to admit at least that I do not notice, any difference in it.

But I will favor what you say: I like to use the mill with the larger rolls due to the rigidity, and that point certainly cannot be stressed too much in seamless tube making. You certainly need rigidity if you are going to make truly concentric tubes.

Another point in favor of large rolls instead of small rolls is the slower rpm at which the large rolls can be operated. This slower rpm causes much better mill operation.

M. S. Gettig: There is one thing I would like to point out as a matter of interest rather than being important, and that is the fact that from the paper you would gain the impression that Mr. Steifel had built several Mannesmann mills in this country. I believe that is somewhat erroneous, since all of Mr. Steifel's mills were of the disc type, and to the best of my knowledge there were no barrel-type or Mannesmann mills built in this country until along about the time of the first World War. By that time they had attached the so-called stripper rolls to the high mill and the modern mills had gained the name of automatic mills from those automatic strippers on the high mill.

In relation to heating, I noticed that Mr. McLaren has said that there are two types of furnaces, that is, the rotary furnace and the solid hearth furnace, and sometime before this meeting is over I would like to have him tell us whether or not, with the sensitive steels that he runs and charging such sensitive steels on a hot hearth as they do in the rotary furnace, there is any damage to the surface. A lot of the stainless steels that he runs are very sensitive to rapid changes in temperature, and I am wondering whether or not he gets any cracking from charging these billets or rounds on the hot hearth.

In regard to guiding, it seems that everybody admits

that guiding in a mill is about the most important thing there is to be considered. Mr. McLaren has almost an unlimited number of outside diameters in which he can make his tubes. He can start with a uniform round diameter and more or less through free expansion and the choice of plug size, can come out with pretty nearly any size he wants. He states in effect that starting with an optimum round size through free expansion, and the choice of plug size, the outside diameter of the billet coming through the piercer will be a function of the wall thickness. Therefore, piercer shoes with varying degrees of step are required to permit this expansion to take place without undue "holding down" or "guiding." Conversely, if it is desired that the billet come out of the piercer at a uniform outside diameter, the round diameter going in should be a function of the wall. It is necessary that the billet coming from the piercer be of a uniform outside diameter regardless of wall so that it may enter a given size of high mill groove. Unfortunately, some mills do not find it economical nor feasible to vary the round diameter going into the piercer to obtain the same outside diameter as the billet leaves the piercer, and consequently it is necessary to guide or hold down the outside diameter of the billet using the mill guides to accomplish this purpose. Any attempt to vary the round diameter to accommodate billet diameter would result in frequent piercing mill changes and render mill productions unprofitable.

In relation to plug design and roll contour, I think it is pretty much as Mr. McLaren has stated, a choice of whatever is required by the individual characteristics of the mill.

H. R. McLaren: Mr. Gettig is absolutely right about the disc mills built by Mr. Steifel. I did not mean to infer that they were Mannesmann mills. They were seamless mills, although Mr. Steifel did run the original Mannesmann mill in Europe.

I am glad he brought up the heating problem because I am sure some of the bar men present may be thinking about this. It has been proven at our plant, before we installed the rotary hearth furnaces, and many times since we have had them installed, that charging rounds on a hot hearth does have absolutely no detrimental effect, and we have run tons and tons of SAE 52100, one of the most sensitive steels, 4340, and our graphitic steel which runs 1.50 or 1.60 per cent carbon. If any steel is going to break or spring by charging on hot hearths, those steels would. We have had no trouble from that angle, but I will tell you the reason. Rounds do not have any small corners, such as you have on the squares in the bar mill, to overheat ahead of the main body, and therefore, expand previously to the main body. The rounded corners are what makes it possible to charge seamless rounds on a hot hearth.

In regard to guides, I realize that we have to be practical in our guide design, but I am sure Mr. Gettig will realize that he uses a certain design on his first piercer. That is heavy-wall piercing. He uses another on the second piercer. That is light-wall piercing. We use a third design which we call medium wall piercing. The expansion when passing through the piercing mill is a function of the wall produced; the heavier the wall, the less the expansion; so you would always have light and heavy wall shoes, but if you really want to go to the extreme, which we have to do in our mechanical tubing, we add the other guide, the medium wall guide.

A. G. Ericson: What about the amount of maintenance on the rotary hearth furnace, the mechanical features as well as the brick work on the hearth?

H. R. McLaren: We have two rotary hearths. The maintenance cost is very low, and the reason it is low is because we put a raised track, made up of checker brick, on which we set the steel. When this wears down due to charging and discharging the rounds in about nine months, we shut the furnace down and just lift these out (they are not fastened) and go around and put another group in.

At that time we also clean the bottom of these furnaces, because we do not have any other opportunity to get the scale out. Charging the hot rolled rounds directly on a hot hearth pops the scale off. That is really a type of descaler. In fact, that process is used for descaling. So we get a chance to clean that scale out when we take these bricks out, which is in the neighborhood of every nine months.

That is the only maintenance we have had on our furnace since it was put in in 1943, putting the tracks on, and the door changes. We have a charge and discharge door that we have to change.

Professor W. Trinks: Most of the papers that have been read about seamless tubing were all of the type in which language was used to conceal the speaker's thought, but the present paper is entirely different. In other papers everything was kept secret and not very much was said about cone angles, feed angles, and other things.

I believe that he is in error when he says that the rotary furnace did not come into the picture until 1940. I myself designed one of the first very large rotary furnace for this country in 1918, or it may have been 1919, and in my books on industrial furnaces I have been preaching rotary furnace, rotary furnace, etc. Mr. Dauch says he designed his large furnace one month ahead of mine. This also was a very large one, so it is somewhat ancient compared to 1940.

I have a question to ask. To my mind, the entering cone has the purpose of gripping the round bar, and either pulling or pushing it through, over a mandrel. If that part (the entering pass) is very smooth, you will need more pressure and a larger contact area, but if it is rough you can have a shorter entrance cone and you would not twist the tube so much. Does your company use either a knurl- or acid-roughening on the inlet cone?

H. R. McLaren: As far as the acid is concerned, they use a little but I wish they would not use any. They do not use it when I come around. If you will notice the rolls on the mill you will see a knurl. I do not know whether we are the only ones using this knurl or not, but we use this knurl all the time. It is no secret and I think I have given this knurl to most of the boys in the seamless industry if they cared to put it on.

It does help out in the pulling of the steel, into the mill. You cannot put the extra contact to pull steel in because all of our improvements in the seamless industry that I remember since I came in the game, have been around the removal of that contact, so we can pierce the more sensitive steels, and we are piercing much more sensitive steels than we did twenty years

ago. Regarding rotary furnaces, I know that our two furnaces are the first installations made on seamless piercing mills in the United States up until that time, the first in 1941 and the second in 1943.

S. Findlater: While presentation of the subject has been most comprehensive, there are some additional points which might possibly be of interest. Mr. McLaren has emphasized the importance of guiding in the piercing operation. We have found that in addition to the function that the guides perform in holding the centerline of the work piece in the centerline of the pass, they can, if properly contoured, be made to perform a second vitally important function; namely, that of maintaining circularity in the section of the work piece during its passage through the piercing mill. When the working surface of the upper and lower guide shoes is properly contoured, the section of the work piece can be made to approach circularity, thereby minimizing guide shoe friction and effectively eliminating sharp bends in the wall of the pierced billet as it is being processed. In piercing certain steels with improperly contoured guide shoe surfaces, the sharp bend produced may actually cause rupture of the inner or outer surface of the steel. Obviously, when such condition occurs, the guide shoe friction is considerably greater than that which takes place when the piece is forced to remain in substantially circular section.

We have also found it advantageous to maintain the centerline of the plug as nearly as possible in the centerline of the pass. In other words, if the distance between the contact surface on one roll under the plug around to the contact surface on the other roll is equal to the distance from the contact surface on the one roll over the plug to the contact surface on the other roll, the reduction made in the wall thickness between each roll and the plug will be equal. If this condition is not maintained, and the distance from the contact surface of one roll under the plug to the contact surface of the other roll is less than the distance from the contact surface of the roll over the plug to the contact surface of the other roll, the reduction which must be made when the metal passes between the roll and the plug will be greater on one side of the mill than on the other side. This is brought about by the fact that less than 180 degree rotation of the work piece is required in passing from contact area under the plug to contact area, while more than 180 degree rotation of the work piece is required in passing from contact area over the plug to contact area. The axial centerline of the plug, therefore, cannot be in alinement with the centerline of the work piece or the centerline of the mill. This means that for the best operating conditions, the plug size should be as large as is consistent with requisite clearance.

As regards roll face angles and plug contours, it may be interesting to note that careful analysis of these two factors was made some years ago by my company and it was found that by properly contouring the plug with respect to the roll face angle, the incremental reduction in the wall thickness could be made to follow a geometrical progression. The astounding observation which was made when this properly designed pass was first put into use was that with the same feed angle in the piercing rolls, the advance per revolution was 100 per cent faster than had been obtained with the old type piercer pass, and that in spite of this tremendous increase in rate of feed through the mill, the actual motor load had increased only about 20 per cent. The feed efficiency in the old pass had been approximately 40 per cent; whereas, the feed efficiency in the geometric pass is approximately 90 per cent. The fact that the motor load did not increase correspondingly is definite proof that guide friction was reduced and that work which had previously been wasted in actually upsetting wall after it had been reduced was eliminated. As Mr. McLaren has pointed out, this geometric pass also made possible the use of considerably less draft than had previously been required.

H. R. McLaren: You are absolutely right when you say the circular part of the shoe is holding and guiding, because very definitely, as Mr. Hamilton stated, you have to keep the shoe guiding the steel or the guides are no good.

As for the guide friction causing ruptures, that, again, is right, because that is very noticeable, if you happen to leave your guides in too long when you are piercing very sensitive steel, such as 25Cr12Ni and 25Cr20Ni, when they begin to wear out, you begin to get outside and inside diameter defects.

Keeping the plug in the centerline is a very good point. We had that brought forcibly to our attention in the production of the 75 mm gun barrels that we made during the war. When we were first developing that, we were stopping tubes partially pierced in the mill and cutting them up, and we found in those in which the plug was not in the centerline, it reduced the concentricity, so we made revisions to be sure it was started in the centerline by setting the plug correctly. Then due to the fact that the forces are balanced and the tube desires to ride through the center if you give it a chance, that plug stayed in the center, and that did account for concentricity.

S. William Stouffer: It occurred to me that there are a couple of items mentioned in the paper which are subject to development. Mr. McLaren stated he found that d-c motors were of some advantage in piercing stainless steels. It seems that considerable work could be done in the development of d-c drives on piercing mills for carbon steels. One advantage for instance, is the ability to compensate for change in the roll diameter. A typical mill would use a roll, say, of 36 to 42 inches in diameter range. For a constant-speed motor this means a variation in production rate of 10 to 15 per cent, which could be compensated for with a d-c drive. At the same time, I am sure there is considerable room for exploitation of the optimum piercing speeds under different rolling conditions, including such items as the length of billet, the amount of reduction, and so forth. With a d-c motor it is possible that greater piercing speeds could be obtained than are now considered feasible with the conventional a-c drive.

Another thing which is controversial in the seamless operation is the question of plug contour, as provided by the cast plug versus the machined plug. I wonder if Mr. McLaren has had any experience along this line and would tell us his preference as to the cast plug surface compared with the better concentricity obtained with the machined plug.

H. R. McLaren: I have had quite a chance to study the machined plug because we use a tiny plug in our

Wooster mill, and we had quite a problem obtaining that casting during the war. At that time, I was thoroughly of the opinion that one of the important points in obtaining the ultimate in concentricity was a machine plug. We had plugs machined from bar steel to make up for the shortage of castings. Since that time, I have changed my mind because of the fact that we did not gain the improvement that I thought we would gain from the machined plug.

That runs into another point. The machined plug and the cast plug both have to be made to fit loose in the bar cap. If they fit tight on the bar cap, the machined plug will make eccentricity, so will the cast plug, because you transmit the whip of the bar directly to the plug, and cause the plug to weave off during the piercing, whereas if you allow it to float slightly loose in the bar cap, it will pierce concentric.

If you have your mill set so that the forces are equalizing, it will pierce concentric, even though the plug is slightly out of round, because the out-of-round side is exactly opposite the other side and it does not hurt nearly as much as I originally thought it would. So, the biggest thing we gained out of the machined plug was the constant setting or looseness of the plug in the bar cap.

Relative to d-c motors for piercing carbon steel, I feel that all piercers should be equipped with d-c motors. The correction of stickers alone would justify the installation. In addition to this advantage, you have the extra flexibility of operation of the mill which allows extra speed on the small rolls, and extra adjustment for the light wall or other critical piercing sections.

ASSOCIATION OF IRON AND STEEL ENGINEERS

PITTSBURGH DISTRICT SECTION

Inspection Trip to Weirton Steel Co.

WEIRTON, WEST VIRGINIA

Monday, May 10, 1948

Inspection Trip — Group will assemble promptly at 1:00 p.m. at the Strip-Steel Division using No. 5 gate. Parking facilities will be provided at this point. Inspection trip will terminate at No. 1 gate where buses will pick up group to return them to the parking area. Group will then use their own transportation to go to the Williams Country Club at Weirton.

Dinner and Meeting

WILLIAMS COUNTRY CLUB, WEIRTON, WEST VIRGINIA

SOCIAL HOUR — 5:30 p.m. DINNER — 6:30 p.m. MEETING — 8:00 p.m.

($4.00 per Person)

New Cold Mill at Weirton Increases Tin Plate Capacity — by C. J. Klein, Chief Engineer, Weirton Steel Company, Weirton, West Virginia

Electrical Drive Equipment for New High Speed Tandem Mill at Weirton — by A. F. Kenyon, Steel Mill Engineer, Westinghouse Electric Corporation, East Pittsburgh, Pennsylvania

Send Dinner Reservations to Headquarters AISE, 1010 Empire Building, Pittsburgh, Pennsylvania

Fibrous Glass - -

ELECTRICAL INSULATING MATERIALS

. . . . the development of inorganic insulations, particularly those made of glass fibers, makes possible motor operation at higher temperatures with less maintenance than was formerly possible . . . .

By HARRY O. COLLIS, Electrical Engineer
Owens-Corning Fiberglas Corporation
Toledo, Ohio

▲ ONE of the most important recent developments in electrical insulation is the extended use of fibrous glass textile materials. The production of glass in textile form for electrical insulation has expanded tremendously since commercial development started in 1938. The design of special electrical equipment for war use familiarized many designers with the properties of fibrous glass and will enable them to produce better electrical equipment for peacetime industry.

Glass has many properties that are desirable for electrical insulation. Although brittle under impact, glass is strong in tension and compression and is capable of being cast, blown or pressed into many different forms and shapes. Glass is stable under extremes of temperature and humidity. It is an inorganic material, and its life is indefinite. Glass is as ageless as the mineral ingredients that are its major components. Glass bottles and bowls have been taken from the tombs of Egypt and ancient man made knives and arrow points of obsidian and quartz, which are glasses often found in nature.

The use of glass as electrical insulation is as old as electricity itself. Figure 1 is a photograph showing a reproduction of an electrical laboratory typical of 1880. These early experimenters used glass for their Leyden jars and to hold the chemicals for their voltaic battery cells. Glass was chosen because it was the only insulating material suitable for these applications.

A process for commercial production of glass in textile form was developed about 1938. An experimental pilot plant was in operation for several years before 1938, but the first active sales promotion began about that time. Fibers of glass are basic components of many different products with many diverse applications. Glass fiber yarn is the basis of electrical insulation materials. Two processes are used for producing glass yarns in two forms — staple fiber and continuous filament. Continuous filament is made up of fibers of great length limited only by the size of the winding spools. Yarns twisted from continuous glass filaments are smooth in appearance and are naturally white. Continuous filament glass yarns have "sheen" and look a great deal like rayon and silk yarn. They may be dyed any color for use as electrical tracers.

The staple fiber yarn is formed from relatively short fibers, which average about 6 to 18 inches in length. Materials made from staple glass fiber yarns resemble wool or cotton materials in appearance.

The continuous filament and staple fiber yarns are twisted and plied on standard textile machinery. Continuous filament strands are built up into yarns with diameters ranging from about 0.003 to about 0.040 in. Staple fiber strands are twisted and plied into yarns that range in diameter from about 0.010 to about 0.070 in. The continuous filament product is used for approximately 95 per cent of all fibrous glass electrical insulation materials. In the forming process, a small amount of lubricant is applied to the basic strand to simplify the handling of the fibers. This lubricant reduces the friction between fibers and increases resistance of the yarn to external abrasion.

The glass used is a special high quality type, designed particularly for electrical applications. "Electrical" glass differs from ordinary glass in that it has an extremely low alkali content. This is an essential requirement since high alkali content will adversely affect electrical properties, such as insulation resistance and loss factor. Raw materials going into "electrical" glass are carefully selected, and manufacture of the raw glass is closely controlled. The electrical glass must be of an even, high quality to insure uniformity of fiber diameter. The glass yarns can be made with fibers of many different sizes, ranging from approximately 0.00010 to approximately 0.00038 in. For many applications, com-

Presented before AISE Annual Convention, Pittsburgh, Pennsylvania, September 23, 1947

Figure 1 — A reproduction of an early physics laboratory, showing glass Leyden jars.

paratively large fibers, at low cost, are satisfactory. More exacting applications require finer fibers with a maximum of flexibility and tensile strength.

Glass yarn is applied to all sizes of magnet wire, ranging from No. 42, used in electronic applications, up to No. 0000 and larger rectangular sections, used for large power equipment. Most glass insulated magnet wire is varnish impregnated to help increase resistance to moisture and to provide protection from abrasion. The impregnants generally used are of a type recognized by the electrical industry as Class B (130 C hot spot) insulation.

Glass yarns are woven into tapes ranging in thickness from 0.003 to 0.025 in. Tapes are available in widths from $\frac{3}{8}$ to $1\frac{1}{2}$ in. Fibrous glass tapes have very high breaking strength and will retain most of this strength at temperatures well beyond those encountered in Class B electrical insulations.

Glass fabrics are woven in thicknesses ranging from 0.0015 to 0.023 in. The cloth is used to make electrical varnished cloth for ground and phase insulation in motors and transformers, as backing for mica sheet materials, and in many other places where a heat-resistant dielectric material is required.

Glass fabric-mica sheets are made in thicknesses ranging from 0.003 to 0.030 in., with glass fabric on one or on both sides of the mica. Laminated plastic materials for electrical insulation are made using glass fiber mats, staple fiber cloth, or continuous filament cloth for reinforcement. Reinforced electrical laminates are used for slot sticks, terminal strips, switch and relay mounting plates and in many other places where high strength and arc resistance are required.

Many different resins can be combined with fibrous glass to produce materials with a variety of electrical and mechanical properties. Glass fiber materials can be combined with phenolic, melamine, or silicone resins as well as the newer, low pressure polyester resins. Fibrous glass-reinforced sheets punch clean and can be fabricated with standard machine tools. Special low loss materials have been developed, using special resins, for high frequency radio and dielectric heating applications.

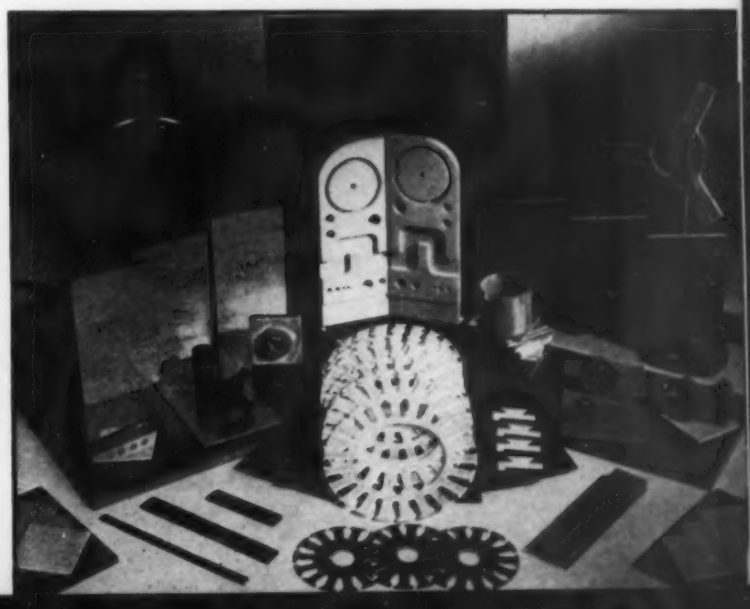
Glass yarns are braided into a full range of sleeving sizes. Braided sleevings are coated with various resins under the requirements of industry specifications, to form single, double, or triple saturated sleeving and varnished sleeving.

Glass cordage is made in diameters ranging from approximately $\frac{1}{64}$ to $\frac{1}{8}$ in. These cords are very strong in comparison to organic materials of a similar size. The cordage is used to secure motor coils, transformer leads, and as the strength member in various plastic-jacketed cable constructions.

Figure 2 is a photograph that shows a variety of glass yarns, tapes, sleevings, and reinforced plastic materials. Figure 3 shows the intricate shapes into which plastics

Figure 2 — Fibrous glass is made into many different sizes of yarn, tape, cloth, cords used for reinforced electrical plastics.

Figure 3 — Plastic materials reinforced with fibrous glass can be worked on machine tools into a variety of shapes used in electrical equipment.



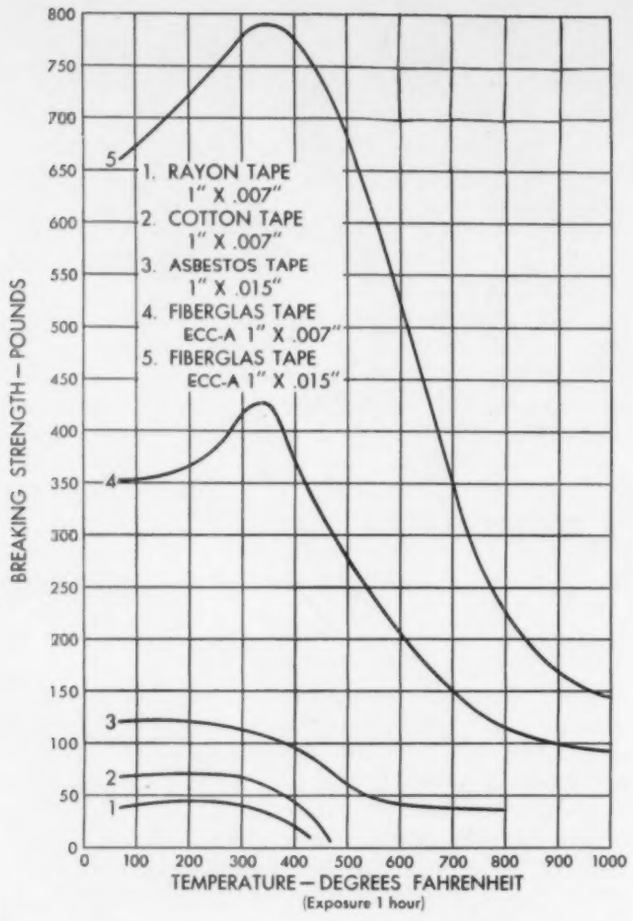

BREAKING STRENGTH – POUNDS
TEMPERATURE – DEGREES FAHRENHEIT
(Exposure 1 hour)
1. RAYON TAPE 1" X .007"
2. COTTON TAPE 1" X .007"
3. ASBESTOS TAPE 1" X .015"
4. FIBERGLAS TAPE ECC-A 1" X .007"
5. FIBERGLAS TAPE ECC-A 1" X .015"

Figure 4 — Breaking strength of electrical insulating tapes at high temperatures.

reinforced with fibrous glass can be punched or machined.

Glass fiber electrical insulating materials are processed into finished form by many different manufacturers. The yarns are processed into finished insulation by many individual companies who distribute their products through the same channels used for the sale of other insulating materials.

Users who are familiar with this variety of fibrous glass insulation materials are often able to reduce equipment failure through proper application of the properties of the glass products. Excessive moisture, exposure to corrosive vapors, and overheating caused by overloads or high ambient heat are the most frequent causes of electrical insulation failure.

Operation of electrical equipment at high internal temperatures quickly ruins the commonly used Class A organic insulation materials. All electrical equipment generates a considerable amount of heat within its own windings. The internal temperature of the winding depends upon the amount of heat developed and upon the temperature of the surrounding air. Where equipment is operated at overload or close to furnaces and other heating equipment, the internal temperature may go up to a marked degree, and this high heat quickly breaks down any weak point in the insulation.

Fibrous glass textile materials used as the basis for electrical insulation are remarkably stable at the temperatures normally encountered in electrical applications. The electrical glass used for the manufacture of glass textiles has a strain point of approximately 1100 F and, up to this temperature, the fine fibers of glass have high tensile strength. In individual fibers, the tensile strength at room temperature may reach 400,000 psi. In yarns, this tensile strength is not fully realized because of the twisting necessary to make the yarn, but the breaking strength is very high compared to organic yarns of similar size.

The strength of glass in fiber form changes as the temperature is increased, as shown by the curves in Figure 4. Figure 4 shows the breaking strength of fibrous glass tapes as compared to tapes made of organic and other inorganic materials. The strength of each tape is plotted against temperatures up to 1200 F.

The room temperature strength of the glass tape increases slightly up to a temperature of approximately 300 F at which point the maximum strength of the fiber is realized. From 300 to 1200 F, the strength curve slopes off gradually but there is still sufficient strength retained at the top temperature to permit the use of the tape in any static application. The strength of comparable size organic tape is considerably less at room temperature and is completely gone at 500 F.

The inorganic nature of fibrous glass is illustrated by Figure 5. This photograph shows a length of glass tape undergoing direct contact with the flame from the bunsen burner. As the photograph shows, the flame has little effect on the glass tape, but has completely burned away the organic material shown at the left. This heat resisting property is utilized in electrical equipment which operates under high heat conditions.

Figure 6 shows handling equipment such as that commonly used for charging furnaces. The furnace shown in this photograph operates at a temperature of about 2400 F. The electric motor which drives the charger is a 16 hp, 725 rpm motor with series field windings and it is exposed to the radiated heat from the open furnace door. The operation is intermittent, and the motor is often subjected to overloads. Originally, the motor was insulated with Class A organic insulation. Maintenance records show that the organic

Figure 5 — Fibrous glass tape and organic tape exposed to the flame of a bunsen burner.

Figure 6 — This furnace charging equipment had markedly reduced maintenance with a glass insulated drive motor. (Courtesy, The Heppenstall Company).

insulation on the series field burned out almost twice a week. This insulation failure forced the manufacturer to maintain stand-by equipment so that down-time caused by failure was cut to a minimum. In addition to down-time and loss of production, it was also necessary to pay for the skilled labor to change the coils and get the equipment back in operation. The manufacturer changed to glass insulation in 1945 and the equipment was still operating in July 1947 without failure. The Class B insulation used to accomplish this result is fibrous glass combined with mica and impregnated with a standard Class B varnish. This Class B varnish (of the heat reactive type) has sufficient heat-resistance to provide an adequate safety factor for continuous operation under the severe heat conditions encountered in this application.

The individual fibers of glass used for electrical insulation materials are actually solid glass rods of very small diameter. The glass cannot absorb any moisture into its internal structure. The surface of the untreated fiber may become coated with moisture, but when the fibers are properly impregnated with a good grade of electrical varnish, the moisture is sealed out and there is no way for the water to get into the interior of the insulation structure. Because the individual fibers will not absorb moisture, the insulation does not swell or contract under varying conditions of high and low humidity.

This property of extremely low moisture absorption has been demonstrated in several ways. Figure 7a shows a set of four test tubes filled with water into which pieces of various types of insulating tape are inserted to determine how much water will be absorbed by the material. Samples were carefully prepared so that the same weight of material is included in each sample. Figure 7b shows the level of the water in the tubes after removal of the samples. This homely demonstration shows that the glass tape absorbs less water than the other type of inorganic tape and the two types of organic materials used.

This demonstration is borne out by laboratory test data as shown by the curves in Figure 8 representing the insulation resistance of various types of magnet wire coverings. The initial insulation resistance of the glass-covered magnet wire is considerably higher than that of similar types of organic-covered and inorganic-covered wire. After continued exposure to 50 per cent relative humidity under a potential of 45 volts d-c to ground, the insulation resistance of the magnet wire decreases to a constant value. The final value reached by the glass-insulated material is much higher than that of any of the other types of insulation materials. The materials used for this laboratory test were standard commercial materials purchased from electrical insulation distributors.

These laboratory data are confirmed by checking maintenance records of coal mining equipment insulated with glass textile materials. One of the first commercial applications for glass electrical insulation was in coal mining equipment. The need for moisture-resisting insulation is obvious when it is considered that coal handling equipment operates in contact with wet earth and water. The drilling, cutting, handling, and hauling equipment is exposed to excessive moisture underground, and then dries out when brought to the surface. Under these conditions of alternate exposure to high and low humidity, an insulation which absorbs water expands and contracts. This "working" of the insulation tends to cause breakdown and results in early failure.

In one coal mine, the locomotives handling the coal cars have used glass-insulated electric motors since they were purchased in August 1936. Up to July 1947 this mine has not experienced a single breakdown due to electrical insulation failure. Each main line locomotive regularly pulls from 80 to 100 loaded cars on each trip out. These cars have a gross weight of approximately 8 to 9 tons. Figure 9 shows a locomotive pulling a loaded train in the main tunnel. The locomotives are constantly overloaded because of the stepped-up production and

Figure 7a — Test tubes and samples arranged to show water absorptions of various insulating tapes.

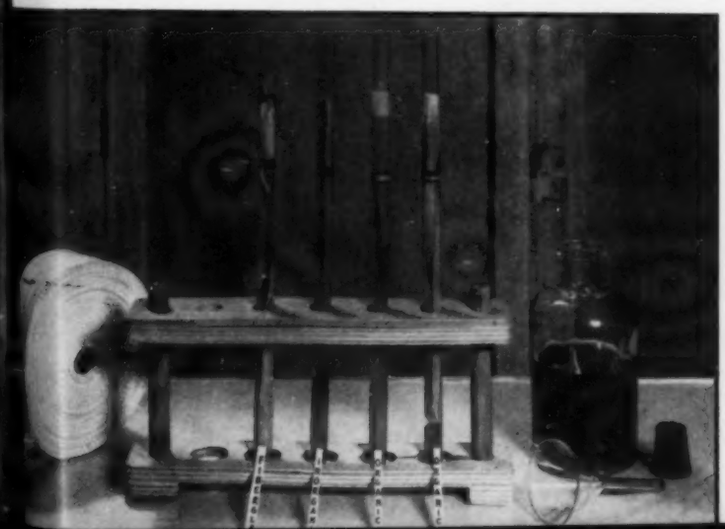


Figure 7b — The reduction of water level in the tubes shows the amount of water absorbed by the various materials.

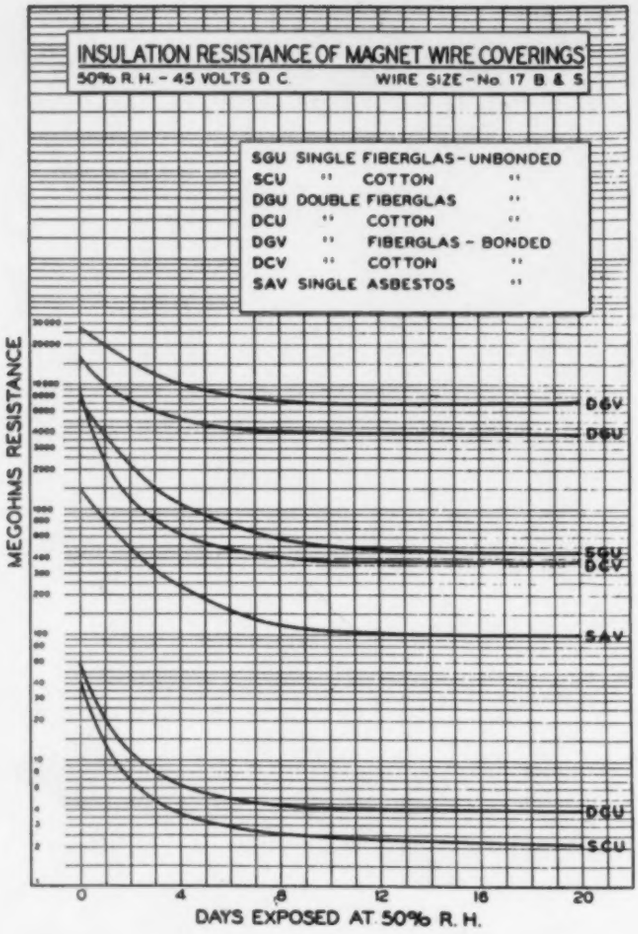


Figure 8 — The effect of exposure to 50 per cent relative humidity on the insulation resistance of various magnet wire coverings.

the improvement of handling equipment. The use of glass insulation in this application has saved time and money by eliminating production delays and costly equipment repairs.

The use of glass bottles for the storage of laboratory chemicals is common. Glass is resistant to practically all reagents in concentrated form, with the exception of hydrofluoric acid. Fine electrical fibers of glass are also resistant to most chemical vapors. The moisture-resisting nature of fibrous glass helps to reduce the effect of chemical fumes on the impregnated insulation. Since the corrosive moisture is not absorbed into the interior of the insulation, the effects of chemicals are greatly reduced.

The resistance of glass fibers to concentrated sulphuric acid is demonstrated by Figure 10. In this demonstration, glass fiber tape, another inorganic tape, and two organic materials have been immersed in sulphuric acid for a few minutes. The two organic materials have been almost completely consumed by the acid, while the strength of the other type of inorganic tape is seriously affected. The glass tape, however, still exists in the original form and has not been seriously affected. The exposure to the concentrated chemical represents what might occur under exposure to weak vapors over an extended period of time. The wide use of fibrous glass insulation materials by the chemical industry bears out this laboratory demonstration.

Figure 11 shows a motor mounted over a vat in which soda ash is mixed for a leaching operation. It is a 3 hp, 725 rpm motor which drives the mixing agitator. Fumes from the soda ash solution surround the motor most of the time. Class A organic insulation usually lasted from three to four weeks under these conditions. The manufacturer changed one motor to fibrous glass insulation in April 1940 and other motors were changed over as the Class A insulation failed. No failures have been reported since the glass insulation was installed.

New developments promise even better utilization of the inorganic properties of fibrous glass insulating materials. The recent development of silicone resins for use in electrical insulation increases the possible operating temperatures for electrical equipment. The heat and moisture resisting properties of the silicone resins supported by fibrous glass materials are still being explored. Experimental units have been built and many manufacturers are considering the design of new electrical equipment built to take advantage of this type of insulation. Industry standardization committees are currently considering the establishment of a Class H electrical insulation that would have a hot-spot temperature limit of 180 C. This 180 C hot-spot is 50 C higher than the Class B hot-spot limit of 130 C. Fibrous glass is one of the few materials which can be used at these temperatures. The higher operating temperature of the Class H equipment will permit the construction of much smaller, lighter weight electrical equipment of every type. The use of silicone impregnants with fibrous glass insulation was developed during the war. Such insulation was used on small aircraft motors that had high intermittent duty ratings.

In addition to the Class H insulation, new designs are now being produced with standard Class B varnishes using fibrous glass as the basic insulation material. Design and testing work was greatly accelerated by the war period, and now several manufacturers are offering Class B insulated equipment as a standard item and no longer consider it a special application. A dry type transformer using Class B glass fiber insulation is about 35 per cent lighter in weight than Class A

Figure 9 — "Main Line" mine locomotives with glass insulated drive motor, Vesta No. 4 mine, Vesta-Shannopin Coal Division, Jones and Laughlin Steel Corporation.

Figure 10 — Concentrated sulphuric acid has little effect on fibrous glass insulating tape, while other materials show quick deterioration.

insulated equipment of the same power rating. Further extensive development of small, light weight equipment has been delayed because of a large backlog of orders for standard equipment.

Acceptance of smaller motor designs by the user has been slow for many reasons. One objection is the fact that some motor users do not like a "hot" motor. For many years a standard maintenance test for electric motors has been simply to feel the motor to check the temperature of the casing. With Class A insulation, a hot casing usually means trouble and points to early motor failure. Modern Class B motors are built to operate at higher temperatures, therefore a hot casing does not indicate trouble. High operating temperatures demand the use of better grade lubricating materials and better bearing design. With the coming of Class H insulation, it will probably be necessary to use silicone greases for motor lubrication.

The use of smaller frame sizes for given power ratings has been explored by most manufacturers. The fact that the "600 series" mill motors are now being sold by several manufacturers indicates that the properties of heat resistant insulation materials can be used to solve some of the toughest problems facing designers of electrical equipment. The 600 series is a special design of commutating d-c motor which has higher horsepower rating in each frame size. Further work with the silicone impregnants may make it possible to go to even higher ratings on the same frame sizes.

Figure 11 — An electric motor mounted over a soda ash mixing tank is exposed to chemical vapors which normally seriously affect ordinary insulations.

New glass developments are now approaching the commercial stage. A pilot plant is now in existence for treating fibrous glass to produce an insulation that can be used at temperatures up to 1800 F. This textile insulation is designed for use in static applications such as thermocouple lead wire, heating elements, and in any wiring that is exposed to extremely high temperatures.

A new fibrous glass mat for reinforcing plastic materials has been developed. Another pilot plant is now under construction for producing the glass mat in large quantities. The use of this mat with low-pressure laminating resins should bring about a reduction in the cost of plastic electrical insulating materials.

Developments are now under way to perfect a process for producing extremely fine fibers of glass. This new type of fiber would produce a more versatile insulation material than either of the two materials now in existence. Small quantities of this "superfine" glass textile are being produced now, and increased production is promised within a few months.

These and other development projects point the way toward more economical insulating materials made of fibrous glass. These new products will extend the application of the glass textiles now being produced and will make possible the design and production of more dependable, longer life electrical equipment.

DISCUSSION

PRESENTED BY

PAUL McKEEVER, Senior Electrical Engineer, Butler Division, American Rolling Mill Company, Butler, Pennsylvania

G. L. MOSES, Section Engineer, Development Engineering Section; A. C. Engineering Department, Westinghouse Electric Corporation, Pittsburgh, Pennsylvania

Paul McKeever: Recently I had need for two hundred feet of fiber glass sleeving of 1¼ in. inside diameter for a special job of insulating flexible copper braids. I was told by a company in this city who specializes on insulating materials only that such an item was not to be had. In fact, the largest tubing they had or could procure was less than one-half inch in diameter. So, I had to settle for some asbestos sleeving that just accomplished the job by using more lineal feet than would have been necessary if I could have secured the proper diameter.

I then proceeded to get in touch with Mr. Collis' company. I was told they had recently turned the glass yarn over to the textile people, with whom I should get in touch. I was given a list of about ten such companies and told about the ones who would also use an insulating varnish in the preparation of such material. The amount of material I needed would have to be set up on a sample machine. What the textile people need is for the electrical industry to advise them of the sizes and wall thickness of fiber glass tubing that can be used. But most important is to have a bonding material

equal to the glass fiber in its resistance to heat and chemical vapors. I have seen glass fiber board under tensile strength tests and also believe it to have a very valuable place in the electrical industry for insulation that would not carbonize at temperatures of 400 F and over.

We have insulated the stator slots of a-c motors with fiber glass board. We have roasted the coils, but never had a motor with this type of slot insulation go to ground.

We have 15 hp motors on stainless slab grinding service that had enamel double cotton covered wire for coils that gave us considerable trouble. We have recently procured a formex wire with glass covering that is doing very well to date. These rewound motors have been in service for approximately four months. I am sure everyone will agree that even though the motors are totally enclosed and fan cooled that the service is quite severe.

We also have ⅓ hp, three phase motors driving furnace rolls on an open annealing type furnace that glass insulation has improved their life. We cannot state what the life will be, as they have only been in service about two months.

We have used glass sleeving on tubing on small motor leads, but there again we were limited to sizes obtainable.

In conclusion, the textile and electrical industries should get together and make available for the iron and steel maintenance people a complete range of insulation for getting better life out of motors and other electrical equipment. I also believe the author's company should pursue their research on this form of insulation until they can get a compound that can be applied to fiber glass insulation to make it more resistant to abrasion and be less affected by moisture.

G. L. Moses: It has been my good fortune to be associated with many phases of the development and application of fibrous glass to electrical rotating machinery and control apparatus. As a matter of historical interest, I would like to repeat statements I made in 1938 for the AIEE magazine. At that time, it was predicted that fibrous glass insulation had the following advantageous characteristics.

1. It is capable of operation under high-temperature conditions, being noninflammable.
2. It has great tensile strength which is maintained to relatively high temperatures.
3. The insulation resistance and dielectric-breakdown strength are both relatively high and are affected less by moisture than are those of conventional materials.
4. The material is nonhygroscopic.
5. It resists attacks by acids, oils, corrosive vapors and vermin.
6. Its thermal conductivity is high.
7. It is more resistant to a combination of abrasion and vibration than asbestos.
8. Impact, except by a knife edge, can be withstood much better than by corresponding asbestos and cotton tapes.

Almost ten years of experience with fibrous glass insulation has indicated that these advantages are very real and of considerable benefit to the electrical industry. Probably one of the most significant advantages of fibrous glass insulation has been the improved reliability which it has made inherent in many machines

Fibrous glass was a major departure from conventional insulation. It made possible many new combinations of insulation with improved thermal endurance without sacrifice in space factor. Before the advent of fibrous glass, most Class B insulations required more space than the Class A and much of the temperature stability advantage of Class B insulation was lost thereby. Fiber glass has comparable space factor to Class A insulating materials.

The availability of a completely inorganic insulating fabric has stimulated the development of synthetic resins with higher thermal endurance. There is little doubt but that the availability of glass insulation greatly accelerated the development of silicone products, which have raised the top temperature limit for machine insulation by a considerable margin.

It might be of interest to review some of the examples of outstanding thermal endurance of insulation employing fiber glass. Mr. Collis has given experience on Class B insulation so my remarks will be confined to Class H insulation which is new enough to be of particular interest.

The first motor successfully treated with silicone resins was a totally enclosed fan-cooled induction motor on which tests were started early in 1942. It was insulated with the best available grade of Class B insulating materials using glass and mica and the finished winding treated with silicone varnish. (Composite silicone resin treated insulating materials were not available.) After complete engineering tests,the motor was overloaded, reaching 416 C in 1½ hours. The load was then reduced until the temperature stabilized at 300 C which was held for 15 hours. Next, the motor was heavily overloaded for a period of 45 minutes, the temperature of the windings reaching 506 C. The motor was retreated and then given a thermal endurance test at a load producing 210 C rise by resistance. Periodically, the motor was dismantled for examination and exposed to a high humidity and various insulation tests. This test continued for a total of 3376 hours at an estimated hot spot temperature of approximately 250 C. The test was ended by the rotor being stalled due to bearing failure. The rotor conductors melted and flowed over the windings. The silicone varnish and fiber glass insulation were still in operable condition and it was evident that the bearing was the cause of failure.

More recently, motors insulated with silicone treated fiber glass and mica have operated at observable temperatures of 300 C for over 8000 hours before failure occurred. Even then it was not the insulation which failed but the copper. Oxidation of the copper at this temperature resulted in increased resistance in spots and failure of the winding due to copper burnout. These windings were periodically humidified and given thermal cycling so that every opportunity was given the windings to fail from moisture penetration under severe operating conditions. This is indicative of the great progress that has been made in the insulation development through the combination of fibrous glass and mica with silicone resins.

Fiber glass insulation has proven itself to be a valuable engineering material during the last decade, during which its use has pyramided many times. There is every reason to expect that it will continue to grow in importance to the electrical industry.

Job Engineering

. . . . machines alone do not give mass production . . . mass production is achieved by both machines and men . . . .

By ROBERT S. DUNHAM, Salaried Personnel Manager
Ford Motor Company
Dearborn, Michigan

▲ ALTHOUGH the techniques and formulae which are used in engineering work have been relatively standardized through years of experience, we are almost in our infancy in job engineering. Our problems are similar in the respect that we both desire a finished product, but, of necessity must achieve this goal through different means.

Our task is far from completed in placing the right man in the right job, although if this basic responsibility is not fulfilled to a high degree of accuracy, that man's relationship to his fellow workers and to their general productivity is out of balance.

For the most part, in the general engineering field, we are dealing with known and proven qualities. When we attempt to apply the same scientific approach to jobs, and men, we are dealing with highly variable quantities. Jobs vary according to the times and needs, while the difficulties of measuring human quantities and abilities are readily apparent.

The history of industry has been one of constantly-increasing emphasis upon the importance of individual efficiency and productivity. We have applied the most modern principles to our production problems, and through inventive genius have designed machinery to achieve the goal of higher production. All of us know, however, that industry can become mechanized only to a certain degree, and thereafter the efficiency of the machines in use is largely dependent upon the efficiency of the men operating them.

Only in recent years have business and industry made concerted and serious efforts to measure the men designated to operate these machines and to perform other essential work, with a view toward placing the right man in the right job.

To place an employee on a job which he does not like — or is ill-fitted for — can be an expensive proposition; consequently, one place to attack rising costs is in lowering labor turnover and promoting efficiency and productivity by proper selection of employees.

This is of the utmost importance in the administrative phases of industrial operations. Failure of a man in an important administrative post may mean considerable loss to the company. By failure, I do not mean normal errors in judgment, but rather, failure to perform the job for reasons which could have been detected before placement of the man. The department with which I am associated at the Ford Motor Company is concerned with the selection of employees to fill the jobs in the category usually designated as "salaried personnel" and with utilizing their capabilities to the utmost.

During the war, the armed services illustrated how men can be selected and trained to do certain jobs — jobs which were extremely important not only to the success of the general undertaking, but of grave importance to the man himself.

Of course, in the beginning, there was much trial and error, but the overall accomplishment was indeed a tribute to American ingenuity and scientific application. Personnel departments in industry barely have penetrated the surface, and broad avenues of progress await our exploration.

The simplest manner through which a personnel department may discover whether a man can do a particular job is to place him on a job with the thought of "let's try him out." This, however, is the costliest method. Industry cannot afford it; therefore, of necessity, we must seek techniques by which we can detect with a satisfactory amount of accuracy the aptitudes, abilities and potential of prospective employees. Industry, in general, and we at the Ford Motor Company, are far from achieving this goal but we have begun the accumulation of necessary data to form the basis of a long-range operation of this type.

To illustrate the similarities of approach in selecting a man for a job and in carrying on a project in a similar engineering field, let us consider for a moment the problems involved in designing a carburetor for a gasoline engine. Certainly, just any carburetor will not do. The engineers responsible for the design of this mechanism first must have complete information about the engine itself, and the specific job which the engine will be expected to do. In other words, they must know the performance standards. The carburetor destined for use as an integral part of an automobile to be entered in the Indianapolis speedway classic must be a very different design than the carburetor for an engine which will provide power for an airplane. Likewise, a carburetor for a truck engine designed to pull heavy loads for long distances over mountainous terrain hardly would be suitable for a passenger car engine.

In requesting additional personnel in industry, department heads often impose a serious handicap on the

Presented before AISE Detroit District Section Meeting, October 8, 1946

personnel department by not providing enough information regarding the job to be done. This information is the first, and one of the most important steps toward successful job engineering. No personnel department can operate effectively without it. Just as the automotive engineer must know what is to be expected of the engine he is asked to design, so we must know what the individual we are requested to select will be expected to do, and of paramount importance, under what conditions will he be expected to perform.

After the requirements for this new carburetor have been established, it is the job of the engineer to design a unit that will provide the best performance over the longest possible period of time. Similarly, it is the responsibility of the personnel department to employ for a specific job a man who will be the most productive in that line of work for the longest period of time. High personnel turnover is costly in any line of business. Unlike the mechanical engineer, however, we cannot design and build a man to fit a particular job. We must select from the available market the best prospect. Our task in this respect is difficult or simple, according to the general labor market. Under present conditions, it is necessary to develop sources of exploration to discover men to fill particular jobs. No personnel department can afford to wait for the man to come to the job.

In requesting additional personnel, or when contemplating such additions, supervision would do well to draw up the specifications of the ideal man desired — the ideal in experience, education and personal qualities. Using these specifications, the personnel department then may seek to find this ideal employee for a particular job. Of course, all of us know that these specifications will, of necessity, have to be tempered here and there in the light of manpower available.

If a position requires experience, we want to find the man with a sufficient number of years behind him, but of greater importance, with a sufficient number of productive years ahead of him. Also, we must bear in mind that we want to keep this man for the remainder of his productive years, and that means he must be satisfied with the job, not only satisfied with it at its inception, but a high degree of satisfaction must be maintained through the years.

It is a serious error to place an individual in a job which is far beneath his ability, since he soon will recognize the fact and immediately will desire responsibilities commensurate with his work potential. Every man likes to be busy, to work hard, and to feel a sense of accomplishment. It is in many instances better to place an individual in a position which will require slightly more of him, than his experience warrants, because with the proper supervision, he can pull himself up to the job, providing sufficient challenge and accomplishment for him.

After the job specifications have been set up, and the prospective employee's qualifications determined to be in line with them, the highly intangible human element enters the picture — the element of personality, temperament and social characteristics. As an example, consider the difference in temperament required to do public relations or sales work, as contrasted with the ideal temperament for engineering research. A very simple illustration can be found in stenographic work. Some stenographers perform exceptionally well in a large department where many other stenographers and typists are at work, but they lose their self-confidence and initiative completely when assigned to an office where they work alone.

The opposite also is true. Many stenographers who are, in reality, highly efficient secretaries, do very poorly when assigned to perform in a large group. Experience, of course, dictates some of this reaction, but differences in temperament also play an important part.

The ultimate goal of any personnel department, of course, is to devise formulae for selecting the right individuals for the right jobs, and to be able to predict, with a high degree of accuracy, their future success on the job. Many extravagant claims have been made for methods and systems advocated by personnel experts and psychological vocational counselors. The difficulties of achieving success in this field are apparent. Time, and much research, are necessary. We feel that if by using selection methods which we have today, we can eliminate a high percentage of those who would be misfits on the job, we will have accomplished much.

If, through time and research, we are able to predict a degree of success, we will be approaching the ultimate. The latter will take much time. Many aptitude and psychological interest tests have been devised for personnel work. They are designed to reveal the individual's conscious and often sub-conscious interests and abilities. We believe in utilizing such tests and measurements under certain conditions and for specific purposes, but we also are aware of the definite limitations of such instruments, and the imperfections in them.

To attempt to measure such characteristics in a young man, and by such measurements direct his employment destiny, is a great responsibility. If however by utilizing these measurements, adapting them to specific jobs in a specific industry, measuring the success of the individuals tested, and correlating this success with the test results, we can accumulate sound data for research, we then are contributing materially to our task of job engineering. Such tests are only of value to any specific industry to the extent they are correlated with the job in that particular industry.

A salesman in our company possesses different characteristics from a salesman in the chemical industry. A measurement designed to discover general sales ability has definite limitations when applied to specific sales positions. If the test is used as an indicator, and the generalities realized, it can be of some value, but to utilize such results as a specific measurement of success as a salesman in a particular company, would be a fatal mistake.

At present, we are utilizing performance and aptitude tests only as measurements in the fields of stenography, typing and business machine operators. It is our feeling that we should confine testing to these groups, exerting every effort to improve the effectiveness of the instruments before delving into the higher and more complex classifications. We have taken standardized tests, adapted them to our needs, and are in the process of performing a very close follow-up check on each individual in the group tested. We hope to validate the testing instruments we now are using in terms of success on the job.

As we mentioned previously, placing the right employee in the right spot is but the first basic responsibility of a personnel department. Insuring future job satisfaction and continued improvement in employee productivity is achieved through promotion, salary increases, and careful counseling. Many problems develop after the employee is placed which appear to be insignificant on the surface, but which seriously affect his productivity. Unless these problems are dealt with immediately and successfully, they pyramid in the employee's mind until his dissatisfaction mounts in almost direct relation to his lowering productivity.

Many supervisors have felt that they should not be concerned with the solution of such problems; however, experience has taught us that a great portion of the efficient supervisor's time is spent, of necessity, in assisting employees working under his direction in the solution of their problems.

With us an important responsibility of the salaried personnel department is to provide an avenue for discussion with employees who have problems which they feel cannot be taken up with supervision. No personnel department can, or should, arbitrarily dictate to supervision. However, by sympathetic understanding of the employee's problem, and through discussion of this problem with supervision, a satisfactory solution can be reached in most instances. Our job is to bring the employee and supervision together in their understanding of the mutual ramifications of the problem, so that its solution may be approached through a mutual point of view.

Serious attention must be given today in large industries to the orientation of new employees. The easiest course is merely to place the employee on the job with the often cold admonition "here it is, now go to work." Unless each employee feels the importance of his individual effort in relation to the over-all successful operation of the industry, he very often feels lost. He feels the company does not have a sincere interest in his welfare, and he cannot be expected to take a high degree of personal pride in his work because he has no means of determining its relative importance. The feeling of "belonging" to an organization is essential to all of us.

We meet every week with all of the new employees hired during that period. We discuss with them their privileges and benefits as Ford employees, inform them of the historical background of the company and outline the general personnel policies. We feel it is also important to inform new employees of their obligations to the company. They witness a motion picture of operations in the Rouge plant, which graphically brings to them the vastness of the enterprise, and every effort is made to bring out the individual importance of each of them to the production of a good automobile.

Purposely, they have been on the job for several days prior to our discussion, since we feel that in that time they have had the opportunity to observe and question methods. It is our job to answer the questions which have arisen in their minds. Naturally questions arise from time to time in the minds of employees already on the roll concerning their place and future in the organization. It is our policy to discuss with each employee very thoroughly his background, employment history with the company, and specific job responsibilities. We attempt to determine the causes for any uneasiness in his mind. If the causes are such that a transfer to another portion of the company's activity would be to the best interests of all, such a transfer is affected. Everyone realizes, however, that all employees desiring transfer cannot be accommodated. Sometimes the adjustment of a simple problem involving working conditions or responsibilities removes the dissatisfaction and the employee's desire to be transferred.

There are some instances in which supervision objects to losing a man because he is "doing too good a job." Unless supervision is continually grooming each man to fill a position on a higher level, within the department, an important part of supervisory responsibility is not being fulfilled. There always should be one or more employees being trained and equipped to take over the job above them. Unless this is done, and the employees are aware of it, the feeling that a lack of opportunity exists soon permeates even a large organization.

We have many plans for the future and are attempting to proceed slowly, building on a sound foundation, and we have very much to learn. The operation with which I am associated is but a part of the emphasis at the Ford Motor Company on the importance of the human factor in industry.

Last June 4, Henry Ford II, president of the Ford Motor Company, announced plans for construction of a 50-million dollar research and engineering center in Dearborn. This center will be one of the largest developments of its kind in industry, and will take approximately 10 years to complete. Dedicated to Henry Ford, founder of the company, this project will carry out Henry Ford, II's determination to use every aid which science and research can give to make more and better cars at prices that more and more people can afford. It is significant that Mr. Ford, in announcing this project, also disclosed that, in addition to research and engineering work on the mechanical problems of the automobile business, a portion of the new center will be set aside for research on the all-important "human factor" in industry.

In making the announcement, Mr. Ford reiterated statements which he made earlier that "the mechanics of mass production can still be greatly improved, and they can be more widely adapted, but there is a whole vast area in which we are only beginning to make significant progress — what we might call the field of human engineering. Machines alone do not give us mass production. Mass production is achieved by both machines and men. And while we have gone a very long way toward perfecting our mechanical operations, we have not successfully written into our equations whatever complex factor represents man, the human element.

"I am suggesting, therefore," Mr. Ford continued, "that we try to re-write the equations to take into account the human factor. If we can solve the problem of human relations in industrial production, I believe we can make as much progress toward lower costs during the next 10 years as we made during the past quarter century through the development of the machinery of mass production. This is one of the many important problems we hope to tackle at our new research center."

Design Trends

IN MODERN MARINE POWER PLANTS

. . . . the key to progress in future power plant applications lies in the development of new steels and alloys by the iron and steel engineers . . . .

By FRANK V. SMITH, General Electric Company
Schenectady, New York

▲ COMPETITION is keen between all forms of power generating equipment. Application engineers are working feverishly to perfect new forms of such apparatus, and at the same time trying to put a final polish to the old. This places the whole subject of what may be termed "Modern Power Plant Engineering" on a dynamic basis.

High-pressure, high-temperature steam has lost many of its early fears. Central stations have already authorized money to build power plants operating at initial pressures up to 2000 psi and temperatures up to 1050 F. The end is not yet in sight. Steam tables have been calculated for pressures up to 5500 pounds and temperatures up to 1600 F.

The development of gas turbines has been placed on a regular engineering schedule. No one knows at the present time what the final outcome will be as the problems involved are primarily metallurgical.

The binary cycle using both steam and mercury is also on the march again now that a wetness factor has been added to the characteristics of mercury.

Millions of dollars are also being spent in unraveling the mysteries of atomic power. This may mean that a new competition for power supremacy lies right around the corner.

Compact, high-speed diesel engines were developed to a high state of perfection during the war primarily for use on submarines and auxiliary naval craft. In addition to their marine use, similar sets are now finding wide application for locomotives.

High-speed, efficient auxiliary turbine-generator sets were also developed for naval use during the war. These sets have also become available for use in both marine service and power plants on shore. Add to the foregoing picture such additional economic measures as, regenerative cycles, reheat cycles, and automatic controls for eliminating human errors in operation, and one can see that the application engineer has a pretty full kit of tools with which to work.

Applying this wide breadth of new knowledge to the subject of marine transportation, it may be well to first point out that such transportation has become a critical link in our industrial machine and one of the first to feel the pulse of industrial growth. To keep abreast of the times and escape obsolescence, transportation must continually refresh its viewpoint and back it up with new equipment in keeping with the times.

In the case of land transportation, trains have been lengthened and speeded up to meet increasing demands. Similar methods have been used in deep-sea transportation. Modern ships are being built larger and speedier to meet the demands of a more interdependent world. During the past decade, the tonnage capacity of individual cargo carriers has been almost doubled and the speed of such carriers increased approximately 50 per cent.

Marine transportation is more flexible than land transportation in many respects. The size of the carriers can be progressively increased up to the limitations set by the given trade route and port facilities. Speed is optional in the majority of cases.

TENDENCIES IN SHIP DESIGN

The combination of ship size and speed showing the best overall economy, or in other words, the lowest cost per ton-mile of transporting cargo, is subject to direct calculation and greatly simplified when the nature of the cargo and yearly tonnages are known in advance. The initial cost and operating charges of large ships, small ships, and ships of in-between size, each operating at different rates of speed, can be calculated quite accurately. It is quite obvious that one ship having a deadweight cargo carrying capacity of 18,000 tons, can handle the same tonnage as two ships having a capacity of 9000 tons providing the speed remains the same; and that the larger ship can take the place of three of

Presented before AISE Cleveland District Section Meeting, November 18, 1946.

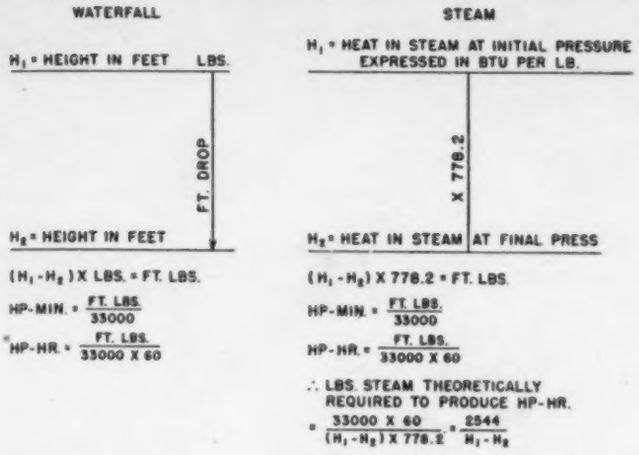

WATERFALL
H_1 = HEIGHT IN FEET LBS.
FT. DROP
H_2 = HEIGHT IN FEET
$(H_1 - H_2) \times$ LBS. = FT. LBS.
HP-MIN. = $\frac{\text{FT. LBS.}}{33000}$
HP-HR. = $\frac{\text{FT. LBS.}}{33000 \times 60}$
STEAM
H_1 = HEAT IN STEAM AT INITIAL PRESSURE EXPRESSED IN BTU PER LB.
X 778.2
H_2 = HEAT IN STEAM AT FINAL PRESS
$(H_1 - H_2) \times 778.2$ = FT. LBS.
HP-MIN. = $\frac{\text{FT. LBS.}}{33000}$
HP-HR. = $\frac{\text{FT. LBS.}}{33000 \times 60}$
∴ LBS. STEAM THEORETICALLY REQUIRED TO PRODUCE HP-HR.
= $\frac{33000 \times 60}{(H_1 - H_2) \times 778.2} = \frac{2544}{H_1 - H_2}$

Figure 1 — These equations illustrate the pounds steam theoretically required to produce a horsepower-hour and compare energy equations with a waterfall.

the smaller ships providing it can maintain an average speed 50 per cent greater than the smaller ships. A correct evaluation of crew's wages, fuel costs, repairs and capital charges enter into studies of this nature.

This tendency to increase both the cargo-carrying capacity and speed of ships may also be noted to a slight extent on the Great Lakes. A few of the recent ships which are powered with modern power plants have a cargo carrying capacity of 18,000 tons and a speed of 14.5 miles per hour, compared to the 9000 to 11,000 ton freighters having a speed of 10 to 11 miles per hour built a generation ago.

PRACTICAL LIMITS OF DESIGN

Increasing the power and speed of a ship has a double effect. It not only decreases the number of ships required on the one hand, but also permits the adoption of more economical forms of propelling machinery on the other.

As a general rule it does not pay to adopt extreme engineering measures for the attainment of high fuel economies in the low power steam field. The application of such measures as high steam pressures and temperatures, reheat cycles, regenerative cycles, and highly refined auxiliary power plant layouts must be placed on a sliding scale with the power rating of the equipment if an economic sense of values is to be maintained.

The subject of fuel economy becomes quite involved in a marine power plant. It is really the result of a combination of factors rather than the effect of a single factor.

Broadly speaking, minimum fuel consumption is attained when the maximum amount of steam is generated for the amount of fuel burned; the maximum amount of useful energy realized from the steam so raised; and the maximum amount of low head heat conserved.

Theoretically at least, the application engineer can project any one of the foregoing elements from the present day practical or economic spheres of application, into impractical and uneconomic spheres with an equal degree of mathematical accuracy in either case. It is the wise engineer who knows where to stop on these ascending scales.

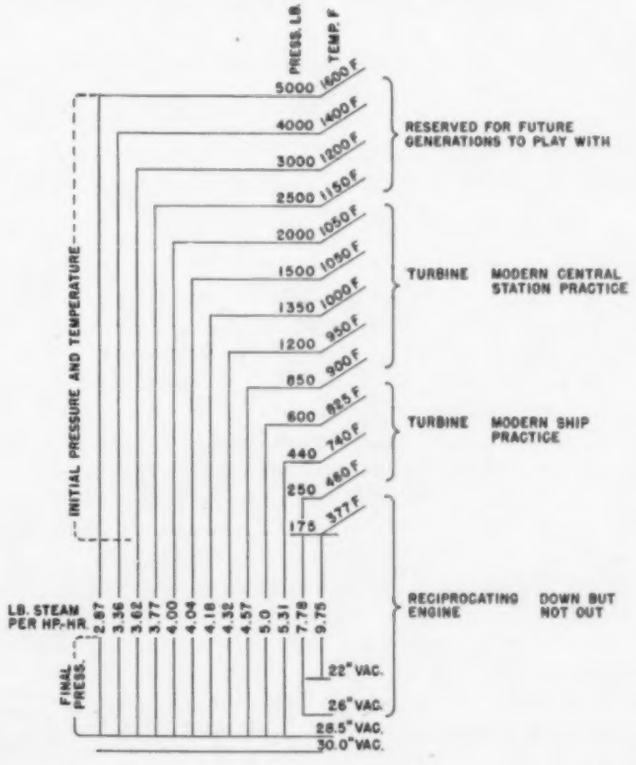
As an example, boiler efficiencies can be increased by regulating the air-fuel ratio down to an absolute minimum for perfect combustion, where no margin of safety against the formation of carbon monoxide exists; and also by reducing the stack temperature to a point where there is danger of flue gas condensation on the air preheater or economizer tubing. Obviously this would be a dangerous procedure in either case.

In oil-fired boilers, such as those used in the deep-sea trade, automatic combustion controls are widely used to maintain high efficiencies yet maintain the proper margins for safety. In the older types of installations in which the air-fuel ratios were left entirely to the operating personnel, it was always difficult to determine the efficiencies which were being maintained once the ship left the dock. The same combustion problems pertain to coal. Hand firing and air regulation simply do not go together. The fireman who will fire thin and often, carefully adjust the draft dampers on all occasions, and keep a steady steaming rate is a rare individual indeed, and probably one who would be worth his weight in gold could he be found. Automatic stokers and combustion controls have been applied to a limited extent on the Great Lakes and this is a step in the right direction.

The turbine manufacturers have been unceasing in their efforts to increase the efficiency of their units. There is a practical or economic limit, however, even in the case of a turbine which should not be exceeded. Going to extreme designs simply to attain the last tenth of one per cent is not practicable, especially where the cost and weight factors of such apparatus far outweigh the benefits to be gained. Here again the power rating of the equipment becomes the deciding factor.

Great progress has been made, however, in the relatively low power field through the selection of more

Figure 2 — Diagram showing pounds of steam theoretically required to produce one horsepower-hour.



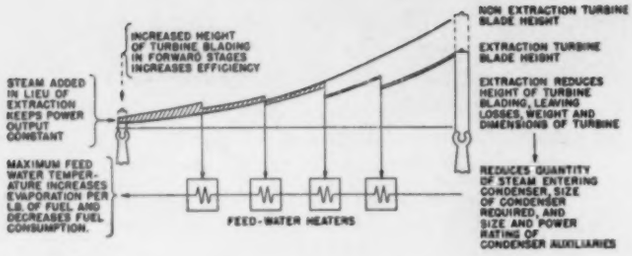

NON EXTRACTION TURBINE BLADE HEIGHT
INCREASED HEIGHT OF TURBINE BLADING IN FORWARD STAGES INCREASES EFFICIENCY
EXTRACTION TURBINE BLADE HEIGHT
STEAM ADDED IN LIEU OF EXTRACTION KEEPS POWER OUTPUT CONSTANT
EXTRACTION REDUCES HEIGHT OF TURBINE BLADING, LEAVING LOSSES, WEIGHT AND DIMENSIONS OF TURBINE
MAXIMUM FEED WATER TEMPERATURE INCREASES EVAPORATION PER LB. OF FUEL AND DECREASES FUEL CONSUMPTION.
REDUCES QUANTITY OF STEAM ENTERING CONDENSER, SIZE OF CONDENSER REQUIRED, AND SIZE AND POWER RATING OF CONDENSER AUXILIARIES
FEED-WATER HEATERS

Figure 3 — Physical characteristics of extraction turbine.

favorable steam conditions, more favorable speeds, and by the inclusion of the regenerative cycle in which steam is extracted from various stages of the turbine for feed-water heating purposes.

The feed-water heating cycles have also been carried to a high state of perfection and within the limits set by good engineering practice. Heat transfer apparatus is installed on all modern ships for salvaging the heat of drains and returning such heat to the boilers via the feed-water path. The limit of good engineering practice may be defined as that point where a further increase in feed-water temperatures would seriously interfere with proper circulation in the boilers, or, where the further conservation of low head heat would entail operating complications far outweighing any material advantages to be gained.

The sensible view to take in all of these engineering matters, is the determination of the maximum overall economy rather than the maximum fuel economy. In addition to the purely economic features of design there are a few items which must not be overlooked in the building of marine apparatus. Such machinery must be built for hard usage, long years of service, minimum expenditure for upkeep, and be fairly simple to operate.

CHOICE OF INITIAL STEAM CONDITIONS

One of the first things to be considered by the application engineer when designing a marine power plant is the selection of the most favorable steam conditions. The most sure method of reducing the quantity of steam required to produce a given amount of power is to increase its expansion range, that is, increase the initial pressure and temperature, and reduce the back pressure.

Although there is quite a little mystery and confusion among laymen regarding the exact meaning and definition of such terms as isentropic expansion, Rankine cycle efficiency, enthalpy and entropy, there is really nothing very difficult about it.

A very simple analogy may be drawn between the available energy in a waterfall when the weight of the water and height of fall is known; and the available energy in steam when the heat content of the steam at its initial pressure and temperature, and the heat content at its final pressure is known. As long as we use horsepower as the basis for power measurement the answer must be expressed in terms of foot pounds in either case.

In the case of the waterfall one simply multiplies the weight of water falling in one minute by the height of the fall in feet to find the foot pounds. Dividing the product by 33,000 gives the result in terms of the horsepower. See Figure 1.

The answer to the steam problem is just as simple when one has a Mollier Chart. One simply sticks a pin in the chart at the initial steam condition, then drops a line straight down the chart to the final steam condition, reads the heat content of the steam at the two ends of the line, subtracts one from the other, and multiplies this difference by 778.26. This gives the answer in terms of the foot-pounds theoretically available in one pound of steam when expanded adiabatically between two pressure limits. Figure 1 shows the simplicity of the calculations.

It is obvious that if one waterfall is twice the height of another, then one-half the weight of water will suffice in performing the same amount of work. The same holds true with steam. If the expansion range is double, one-half the weight of steam is theoretically capable of doing the same amount of work.

There is no lack of data upon which to base one's calculations today, for the steam tables far transcend the field of practical application.

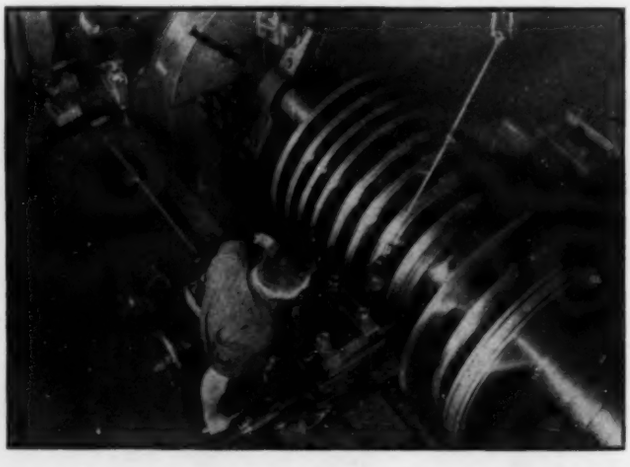
It is unsafe to predict where we are going to stop on this ascending scale of initial steam pressures and temperatures. Looking backwards, some of the old engineers were quite positive in their belief that steam pressures could never be advanced beyond one-hundred pounds per square inch. At the time pressures of 40 to 50 pounds were considered normal and they thought the millenium would certainly be attained at the 100 pound mark when further progress would cease. Puddled wrought iron being the best metal available at the time, the engineers could not see beyond their immediate tools at hand.

The iron and steel engineers seem to hold the key to progress today the same as in years past. Whether one is dealing with jet propulsion, gas turbines, or steam turbines, the story is the same; the application engineers are all looking for metals which will stand high stress at high temperatures.

At the present time, it is interesting to note how far we have advanced on the scale of high-pressure, high-temperature steam, and also what the projected road ahead looks like.

Starting at the bottom of the scale shown in Figure 2

Figure 4 — Dovetail being machined on wheel of low-pressure marine steam turbine rotor in lathe.



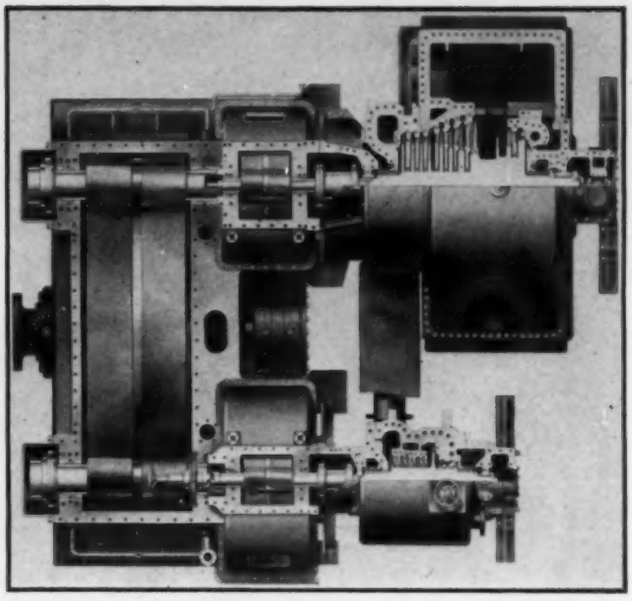


Figure 5 — Cross-compound geared steam turbine unit for ship propulsion.

we find a little of the old Scotch boiler, reciprocating engine era still clinging on in the low power field, with pressures as low as 175 pounds, no superheat, a vacuum of 22 to 26 inches produced by jet condensers and everything operated from a beam attached to the main engine. Add hand firing of coal to this picture, and it carries one back to the engineering in vogue at the turn of the century.

A little further up the scale we find the reciprocating engine drives which have taken advantage of poppet valve arrangements to accommodate the engines to superheated steam.

The marine turbine drives start where the reciprocating engine leaves off. For cargo ships in the 4000 to 8500 shaft horsepower ratings, an initial pressure of 440 psi gage and 740 F temperature may now be considered normal practice. As the power ratings are increased, however, the tendency is to take advantage of higher initial pressures and temperatures. In the 10,000 to 20,000 shaft hp range, an initial pressure of

Figure 6 — Propulsion cross-compound steam turbine and double reduction gear, 8500-hp.

600 psi gage and temperature of 825 F may be considered normal and in larger horsepowers, 850 lb gage, 900 F. Two bulk freight carriers in the deep sea trade have adopted 1400 psi gage pressure, 750 F temperature, with two stages of reheat.

Higher initial pressures and temperatures are used in central stations on shore primarily because of the higher individual ratings of the equipments involved.

In 1925, the average steam pressures used in central stations was only 250 pounds with 350 pounds the maximum. Today over 81 per cent of all central station turbines on order call for pressures above 850 pounds; and 97 per cent for temperatures 800 F or higher. In the 40,000 to 60,000 kw range, 1250 pounds, 950 F may be considered normal. The highest seems to be a 145,000 kw turbine-generator to operate at 2000 psi gage pressure, 1050 F temperature with one stage of reheat to 1000 F. Others in the 100,000 kw class are being designed for 1250 psi, 1000 F, and 1500 psi, 1050 F. Another installation operates at 2400 psi pressure in combination with the reheat cycle.

All of these installations were made possible by the innovation of alloy steels which were first used in connection with power plants in 1926.

As the pressure temperature scale rises, it is anybody's guess as to what may take place in the future. Alloy steels have carried us from the 250-350 psi mark

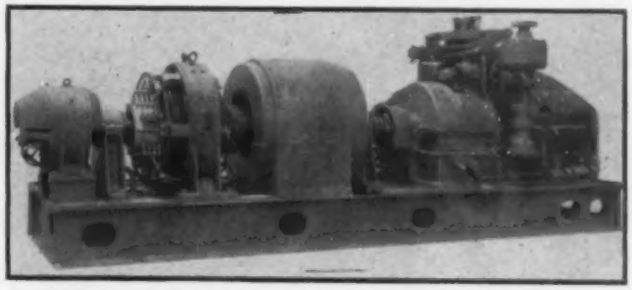


Figure 7 — Geared a-c and d-c steam turbine-generator set for marine service.

of 20 years ago up to the 2000 psi, 1050 F mark of today. Some day some bright young man will throw some untried element into a pot of metal, create a new alloy, and then laugh at our puny efforts the same as we are apt to laugh at our predecessors. The steam tables are all worked out for the younger generations any time they wish to use them.

TURBINE DESIGN

Turbine designers are already bumping into a few of the complications arising from the use of high-pressure steam. High-pressure steam has a very small volume. In small powers, the small quantity of steam required, coupled with its small unit volume, makes it difficult to design satisfactory turbine blading in the initial stages to effectively utilize the energy contained in the steam. Because of this feature, the application engineers have, after numerous investigations, come to the conclusion that the ultimate pressure which can be used effectively bears a direct relationship to the power rating.

Another item to be considered is the moisture con-

tent of the steam in the last stages of the turbine. If this moisture is to be limited to a reasonable amount, then the initial temperature must be increased progressively with the pressure, or resort made to the reheat cycle which appears to be a complication in the case of a marine installation.

THE REGENERATIVE CYCLE

One of the most effective measures used to permit the use of high-pressure steam in the relatively low power field is to incorporate the regenerative cycle in which extraction steam is used for heating the feed-water. There is always a need for low pressure steam for miscellaneous heating purposes aboard ship, and also for use in the first effect coils of evaporators. Modern ship installations make use of extraction steam for all such purposes, thereby avoiding throttling losses insofar as possible.

In all cases where the regenerative cycle is used, the quantity of steam entering the first stages of the turbine is increased to offset the power loss which would otherwise take place. This in turn permits the blade heights to be increased in the forward stages and decreased in the after stages with a beneficial effect at both ends of the turbine.

Figure 8 — 200 in. gear hobbing machine, cutting teeth on large ship-propulsion gear.

The overall effect of this regenerative cycle is to show a substantial increase in the turbine efficiency, decrease in the weight of the turbine, decrease in the leaving losses, decrease in the amount of heat lost in the overboard discharge, and an increase in the number of pounds of steam evaporated per pound of fuel.

Figure 3 shows in simple diagrammatic form the effect of the regenerative cycle on the turbine design.

THE AUXILIARY POWER PLANT

As the steam consumption of the propulsion power plant is progressively reduced by adopting higher initial steam pressures and temperatures, it becomes increasingly difficult to apply non-condensing steam driven auxiliaries and still maintain a satisfactory heat balance. The exhaust from such auxiliaries, as a general rule, is in excess of that which can be absorbed by the feed-water heaters. Even in cases where such auxiliary exhaust can be utilized for feed-water heating, it cancels the fine effect of the extraction system. The tendency in all modern marine power plants is to obtain auxiliary power at the lowest possible rate from turbine driven auxiliary generators operating condensing. This prevents the auxiliary power needs from becoming a burden on the main power cycle.

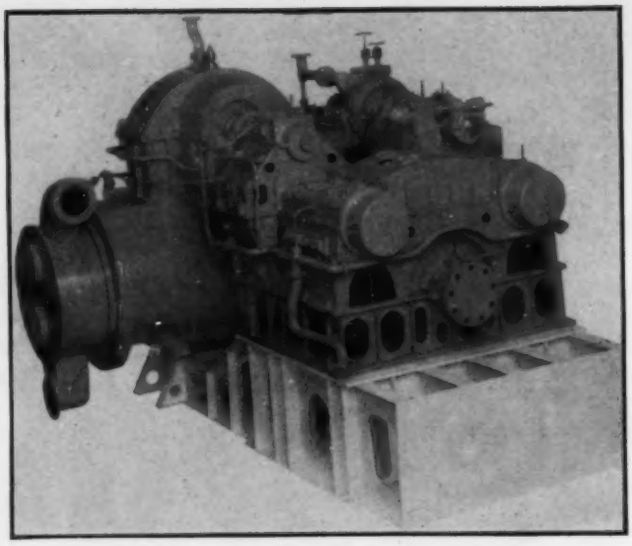


Figure 9 — Model of propulsion steam turbine-gear unit with condenser for C-2, 6000-hp Victory ship.

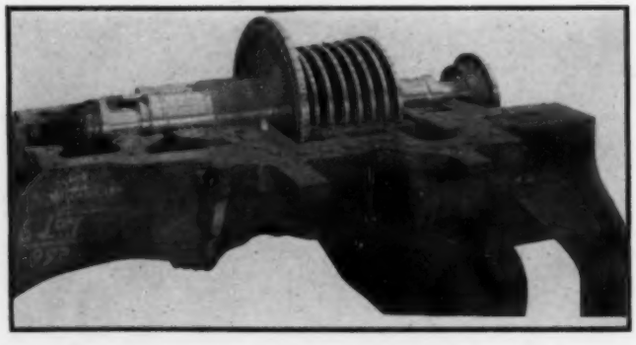
Steam for miscellaneous heating purposes aboard ship is obtained from extraction lines provided in the main turbine wherever possible. This eliminates throttling or available energy losses and further reduces the quantity of steam entering the condenser.

Another tendency may be noted in modern marine power plant design, and that is to utilize alternating-current auxiliaries in place of direct-current auxiliaries wherever possible. A-c motors are tough, simple to operate, and require the minimum amount of care.

OLD ENGINEERING AND THE NEW

Sometimes it is a good idea to look backwards a few

Figure 10 — High-pressure steam turbine, 6000-hp.



years in order to get a proper perspective. When turbines were first applied on ships, they stuck out like a sore thumb. The steam consumption was low, and therefore, the amount of feed-water to be heated correspondingly low. At that time, electric auxiliaries were unknown on merchant ships and used but sparingly on naval vessels. The steam auxiliaries which were developed primarily for use on reciprocating engined ships were pressed into service. Their steam consumption was high, and there was no possibility of utilizing all of the exhaust from such auxiliaries in the feed-water heaters. The excess which was by-passed to the main condenser ruined the vacuum, and otherwise upset the whole heat balance. Because of the danger of oil contamination in the feed-water, the old open feed and filter tank with its loofa sponges was retained. Other antiques were also used, such as twin beam wet and dry pumps. Before turbines could really come into their own it became necessary to practically redesign the entire auxiliary power plant.

The newer engineering is the older engineering in reverse. Every attempt is made in a modern marine power plant to reduce the quantity of exhaust steam entering the condensers. In other words, continual inroads are being made into the condenser losses by getting as much work out of as little steam as possible, and by keeping the maximum amount of heat flowing back to the boilers via the feed-water path instead of throwing it away in the overboard discharge.

In the older jobs, and especially on reciprocating engined coal burning ships, the coal shoveled in by hand at one end, and engine revolutions on the other seemed to be the criterion of efficiency. Little attention was paid to what came in between. Indicator cards were taken occasionally but more to satisfy the curiosity of the home office than for the enlightenment of the operating engineer on watch. The $\frac{\text{PLAN}}{33{,}000}$ formula was the apex of all engineering knowledge and little attention was paid to the paths of heat energy throughout the power cycle.

It is interesting to note how far marine engineering has advanced during the past thirty years. Harking back to the reciprocating engine, hand fired coal, Scotch boiler combination without benefit of superheat, approximately two pounds of coal was burned per indicated hp-hr for all purposes. If five per cent of the power of the main engines was used to drive pumps off the beam and the engines were 80 per cent efficient, then the actual brake horsepower delivered to the propeller shaft was only 76 per cent of the indicated horsepower. This results in a fuel rate per shaft hp-hr for all purposes of 2.63 pounds of coal.

Based on coal having a heat value of 12,500 Btu per pound and a boiler efficiency of 84 per cent which is attainable with modern boilers, automatic stokers and automatic combustion controls, the fuel rates on a modern turbine-gear driven ship will vary from 0.9 to 1.0 pounds per shaft horsepower for all purposes. In other words, a modern power plant only burns from 34 to 38 per cent as much fuel to do the same amount of work. Stated in another way, a modern 4000 shaft horsepower ship will actually burn less fuel than a 2100 indicated hp (1600 shaft hp) ship of the vintage of 1920.

CONCLUSION

One of the things that makes marine application engineering interesting is that there is such a wealth of tools to work with. We are fast reaching the stage where guesses are thrown out of the window for actual and measurable scientific facts. It goes without saying that the work becomes doubly interesting when it deals with a subject as vital to our economy as transportation.

WANTED --- 1924 MAGAZINES!

The Association of Iron and Steel Engineers would like to complete its files of 1924 magazine issues of the *Iron and Steel Engineer*. If anyone has copies of any of these issues please contact:

IRON AND STEEL ENGINEER

1010 EMPIRE BUILDING

PITTSBURGH 22, PENNSYLVANIA

Coke Oven Machinery

. . . . the efficiency of the modern coke oven battery is largely dependent on the machinery which has been developed to charge the battery and to remove the finished product . . . .

By RAGNAR BERG, Chief Engineer
Engineering and Construction Division
Koppers Company, Inc.
Pittsburgh, Pennsylvania

▲ THE purpose of this paper is to give a brief outline of the constructional and functional features of the machinery used in connection with the operation of a battery of coke ovens.

To better understand the progress made in the design of the oven machinery, it would be helpful to first review some of the earlier types of machinery used. As in the beginning of all great industries, it was hand labor that succeeded in coking the first coal. Charging, firing, removal of the product, quenching and loading were all accomplished by the workers in the first beehive ovens. It was hard labor and hot labor, and if ever man earned his bread by the sweat of his brow, it was those first coke oven crews.

As the industry progressed, the need for more efficient methods grew and several machines were developed for drawing the coke from the ovens. Among them was the Smith coke-drawer which used a steam engine to push a wedged shaped shovel under the coke and draw the coke out of the oven on the shovel. The Hibb coke drawer used by the H. C. Frick Coke Company provided a hoe on a rack actuated by a motor driven pinion. The machine was mounted on rails in front of the oven and was provided with an integral turn table so that the hoe could reach all parts of the oven. Next came the Welsh drag oven in which the coke was drawn out by means of a steel drag attached to an engine driven winch. This oven was equipped with a door the entire width of the oven. The Thomas oven was simply a Welsh drag oven with front and rear doors and the drag was inserted after coking. Finally the English reversed the process of the Thomas oven by using a pusher ram instead of a drag. They then added a coal larry and coke loader, and obtained complete mechanical operation of the modified beehive oven. In Germany such ovens were first built by Hugo Stinnes at his Carolus Magnus Mine. Early types of oven machinery are illustrated in Figures 1 and 2. Figure 1 shows a mechanized beehive oven. A coal car, running on a track above the ovens, is ready to deliver its load. The pusher is discharging the coke onto a conveyor, which in turn carries it to a railroad car standing on a track at a lower level. The coke is quenched while passing over the conveyor. The artist has very wisely refrained from showing the great clouds of steam generated when the water hits the flaming coke. Otherwise, you would not have been able to see the plant. It is a matter of conjecture how long such quenching conveyors could last. My guess is that it would have too hot a time for a long life.

Figure 2 shows a cross section of an old Koppers battery, built shortly after the turn of the century. The machinery reflects the style of this epoch, something in the order of a Model T Ford. Three hand pushed buggies take care of the charging. A mechanically operated ram pushes the coke out on a wide horizontal platform, where the coke is quenched before being loaded by hand into cars.

Presented before AISE Annual Convention, Pittsburgh, Pennsylvania, September 25, 1947

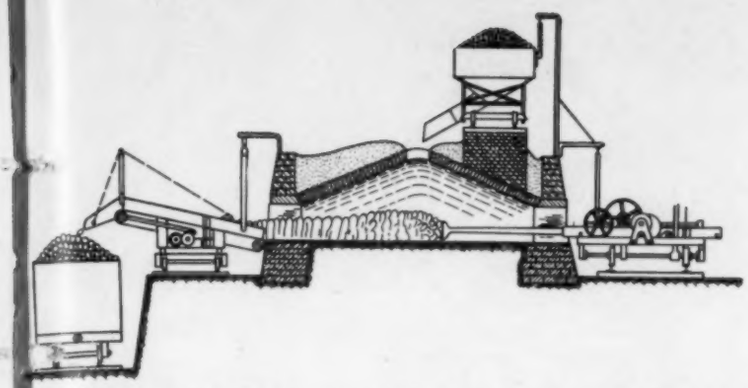


Figure 1 — Cross-section through a mechanized beehive coke oven, showing charging car, pusher, and car-loading conveyor.

Many improvements have been made since the days of the beehive ovens. Nevertheless, the basic principles of oven machinery remain the same. We still use a larry car to charge the ovens and a pusher machine to remove the coke. To these have been added the door machine, coke guide, quenching car, and locomotive. This is the essential equipment for operating a modern coke oven.

It is evident that the modern machines now in use were not developed overnight. They have during the years undergone many changes. Improvements have been made based on the experience gained. New refinements have been added until you see the efficient machines of today.

In the design of a modern coke plant and the necessary machines to operate it, many factors must be carefully considered, thus there have been many different types successfully used, and while it is impossible within the limited scope of this study, to describe all of them in detail, we will endeavor to give a general idea of the machinery of a standard nature used on modern coke plants.

Before going into a detailed discussion of each piece of equipment, I want to show you how the machines are placed on the coke oven battery and the relation each bears to the other. Figure 3 indicates a cross section of a typical oven showing the relative positions of the machinery. On top we see the larry car which brings the coal from the coal storage bins and charges it into the ovens through holes in the oven roof. On the right you will note the pusher machine, which is mounted on rails running along one side of the battery. On the opposite side of the battery at bench level we have the door machine and coke guide. Adjacent to these on tracks at ground level stand the quenching car and locomotive ready to receive the coke when it is pushed from the oven.

In order to obtain a high degree of efficiency, all of the oven machinery must be closely coordinated. The larry car must charge each oven at the correct time. The door machine must remove the door from the proper oven at the end of the coking period; the coke guide must be in place, and the quenching car ready to receive the coke when the pusher begins to operate. One set of modern machines is capable of handling around 200 operating cycles in 24 hours. In different coke plants the time between pushings varies with the number of ovens served by one set of machines and the coking time used. As an example, we may mention one battery of 87 ovens which operates on 16 hours coking time. This gives an 11 minute operating cycle. In order to keep a schedule such as this, each machine must properly perform its function in a minimum amount of time.

As I have stated before, the larry car is a piece of equipment used to transfer the coal from the coal bin located above the battery to the ovens proper. This sounds like a simple operation. However, let me mention a few points which influence the design of such a machine. The number of hoppers and the size of the hoppers will depend on the capacity and construction of the oven to be charged. The hoppers must be so built that all the coal may be freely discharged. There must be little or no spillage of coal and a minimum amount of smoke during the charging operation. The metal, selected for its construction, must be able to withstand the heat and flames from the open charging holes.

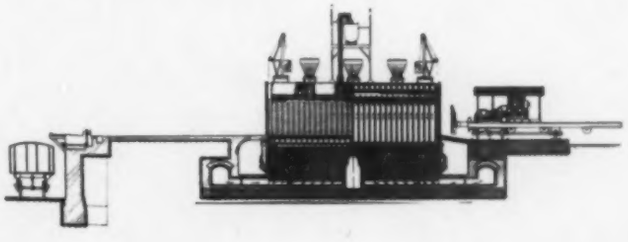
The hoppers are made of steel, often equipped with electric vibrators to prevent wet coal from hanging up. The charging spout itself is made of cast iron for durability and to resist the high temperatures when placed over the charging holes. Sliding gates in the lower part of the hopper allow the coal to be discharged at the will of the operator. These gates are of two types, either operated by hand levers located in the cab or by mechanical drives. The outlet spouts are equipped with retractable sleeves to eliminate spillage. Interlocks are provided which prevent the car from being moved while the charging sleeves are lowered to the top of the ovens.

Inching controls are installed so that the operator may spot the car directly over the charging holes. The car is also equipped with spring bumpers, collecting shoes and a continuous ringing gong.

As this machine is located on the battery top, which especially in summer time cannot be called a pleasant place due to the heat and smoke, elaborate precautions are taken to provide the best possible working conditions for the larry car operator. The cab should therefore be well insulated and provided with large windows for proper ventilation.

The larry cars may be grouped in two general classes, high and low type. Figure 4 shows a car of the high or gantry type. This construction permits access all around the discharge spouts and also provides sufficient clearance between the hoppers to enable the machine to pass a man standing on the top of the battery, an important safety feature. The traction drive for this type of car generally consists of two separate and independent units mounted on opposite sides and directly geared to the

Figure 2 — Cross-section through an old horizontal coke oven built about 1900.



wheels. Each driving unit is actuated by a 15 hp, d-c motor, which allows for a traveling speed of around 250 feet per minute. These double drives have proven a great improvement from a maintenance standpoint over the bevel gear drives used in the past. The operator's cab on the gantry car may be placed underneath the frame where the operator has ready access to the top of the battery or on the main frame where it is farther away from the heat. Some cars are equipped with cabs both in front and rear to give the operator an unobstructed view of the track regardless of the direction in which he is traveling.

The low type car is one which, as the name implies, is built with a low frame and is generally used for four or more hoppers. It is actuated by one central drive connected by means of shafting and gears to the wheels on both sides. This car lacks the advantage of the accessibility around the spouts afforded by the gantry type construction.

Both the high and low type of larry cars are usually equipped with adjustable measuring devices for the volumetric control of the charge, and often provided with scales to record the weight of the coal charged into each oven.

Many modern larry cars are designed to open and close the coal storage bin gates by means of a motor operated device mounted on top of the car. This device is interlocked with the traction drive to prevent the larry car from being moved away from its position under the coal bin while the bin gates are still open. With manually operated gates, it has occasionally happened that the larry car has started away from the bin while the coal was merrily rushing down the open gates and piling up on the battery top, not a welcome sight to the operators.

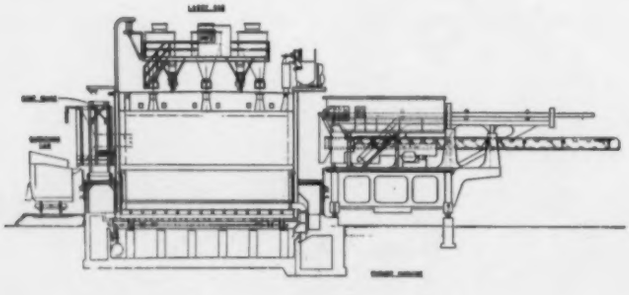
A device for limiting the smoke nuisance and loss of gas when charging is quite often applied to the larry cars. It is essentially a connection from one hopper to another, or one oven to another to permit gas to pass from a pocketed high pressure area in the oven to a low pressure area where it may pass out of the oven through the ascension pipes.

Another method of eliminating smoke consists of a pipe built into the larry car hopper and extending vertically from the spout to a point above the hopper. The idea here is to inject air into the pipe and burn the smoke and gas as it leaves the pipe.

The coal is discharged from the larry car either by gravity or by a mechanical feeding device. The gravity feed, which is still the most common, allows the coal to flow by gravity from the larry hopper into the charging opening of the oven. The mechanical feeder may be one of several types, such as a rotating table, vibrating chute, or a screw conveyor, driven by mechanical means, thus regulating to a high degree the amount of coal being fed into the oven through each charging hole during a given time. The method of regulated charging has greatly improved the quality of the coke due to control of the bulk density of the coal in the ovens. I do not think there is any doubt that mechanical feeders will be more widely adopted for future construction.

Figure 4 — The gantry type larry car permits access all around the discharge spouts.

Figure 3 — This section through a modern coke oven was drawn to illustrate the location of the machinery.



After the coal has been charged into the ovens, the pusher machine swings into action. Let me point out the functions performed by this machine. It levels the coal by means of a leveler bar; it removes the oven door at the end of the coking period; discharges the coke from the oven, and replaces the door after pushing. All of these operations are accomplished by the use of one man and this one machine.

Figure 5 shows one of the latest pusher machines of all-welded design. This construction has been adopted to decrease the weight and facilitate fabrication. To give you an idea of the size of these machines, I may mention that a pusher usually weighs over 100 tons, and has the following approximate overall dimensions: length, 75 ft, 0 in.; width, 27 ft, 0 in.; and height, 30 ft, 0 in. A quite impressive piece of machinery.

Normally, the traction drive on the machines with which I am most familiar consists of one 50 hp, d-c motor, driving two wheels. However, on some pushers two 35 hp motors, or two 50 hp motors are installed, each motor driving one pair of wheels. In certain cases where heavy crane rails of 170 lb or above are not available for the construction of the pusher track, as in some Russian plants, the number of wheels has been increased from four to eight to reduce the load on each wheel. The traveling speed of the pusher machine is calculated to be from 350 to 400 feet per minute.

The ram head which is in contact with the hot coke during the pushing operation is made of cast steel in order to withstand the high temperature and resist abrasion. The ram is driven by means of a rack and pinion drive usually mounted on the underside of the ram.

The movement of the pusher ram is entirely automatic after being started by the operator. After traveling across the space from the machine to the face of the oven at a speed of approximately 90 feet per minute, it slows down and practically stops before touching the

face of the coke. Then it accelerates and pushes through the oven at normal speed. At the further end of the oven it again slows down and stops. The reverse travel is slowed down at the back of the stroke and then automatically stopped. Emergency electrical limit switches bring the ram to a standstill if the automatic device should fail to function.

It may be of interest to mention one special ram construction, known as the open type ram. The use of this ram designed as a lattice girder has practically eliminated the troublesome bowing of the ram due to cold winds and rain striking one side of the ram when it is withdrawn hot from the oven. This type of ram permits uniform cooling of all surfaces resulting in equal contraction of the metal on both sides. An air or steam operated emergency drive is provided to finish pushing the coke from an oven, and to withdraw the ram in case of power failure during the pushing cycle. A carbon blower is attached to the top of the ram head to remove any carbon which may be deposited on the roof of the oven. A motor driven compressor delivers air to the blower nozzle at a pressure of about 100 psi.

The leveler bar used to level the coal after charging is made of welded steel. Two methods of driving the leveler bar are in common use, the pin and sprocket and the rope and drum types. The most popular is the rope and drum type due to its greater flexibility. The bar is driven at a speed of approximately 100-120 fpm. In case of power failure the drive is provided with a large handwheel which is placed on the end of the motor shaft to manually withdraw the leveler bar from the oven. A swinging type chute and hopper are also provided to catch the spillage during leveling. The hopper has a capacity of approximately 50 to 75 cu ft. Some leveler bars are equipped with a small conveyor which lifts the coal from the spillage hopper and discharges it on top of the leveler bar, which then conveys the coal back into the oven on its forward stroke.

The door extractor is usually mounted on the main platform of the pusher machine. Only rarely are independent door machines installed on the pusher side bench of the battery. The door extractor is equipped with devices for loosening and tightening the door latches, lifting the door and moving it away from the oven and replacing it. It is mounted on bronze bushed bearings and actuated by hydraulic cylinders, or electrically operated, through a rack and pinion, or by a crank and rod drive, the last device affectionately known to its designers as "the grasshopper." Complete interlocking is provided. The traction drive for the pusher proper cannot operate unless the leveler bar, door extractor and ram are clear of the oven.

When the pusher ram is withdrawn from the oven, it passes directly below the cab, and to avoid giving the operator what is known as "the hot foot," proper insulation is provided underneath the cab floor. The cab, as in the case of the larry car, is designed with numerous windows in order to give the operator the best possible field of vision and to provide a means of ventilation. Heat resisting glass is used on the side facing the hot oven. There are, of course, the usual accessories, such as spot lights, foot gong, continuous gong, guards, and bumpers.

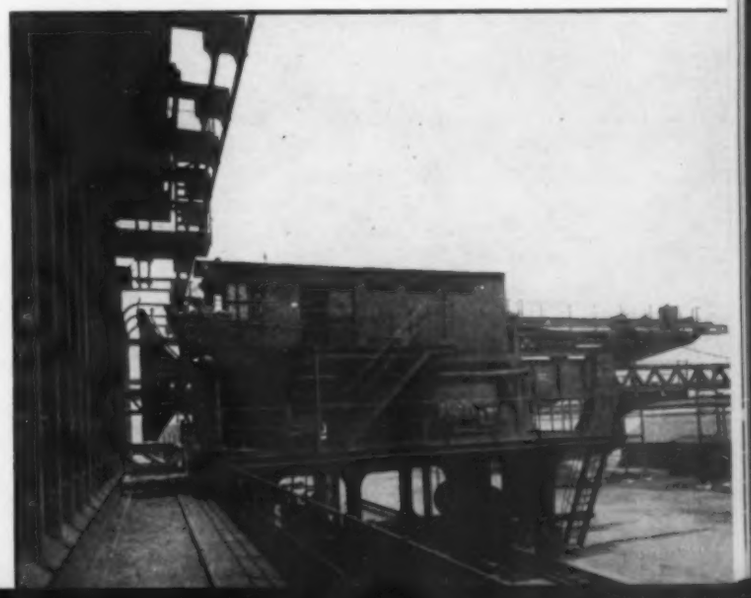
There is also another type of pusher machine in use in certain coke plants abroad, where the coal is stamped and charged into the oven through the end. A coal bin is located above the pusher machine with a rectangular compartment and stamping machine mounted on the pusher. The coal charge is formed into a cake of somewhat smaller dimensions than the oven chamber. The coal is then pushed into the oven while supported on a steel plate which is withdrawn after the oven is charged. In this case the larry car is, of course, eliminated. This method of operation is unsuited to large capacity batteries due to the length of time required to prepare each charge, and is only resorted to when the coals to be carbonized have very poor coking characteristics. The purpose of the stamping process is to bring the individual coal particles in firm contact with each other thus facilitating the formation of a structurally strong coke.

The first coke guide was a very simple affair. It consisted of a rack mounted on wheels and placed by hand into position in front of the oven to be pushed. To avoid interference with the oven buckstays and in order to obtain free travel of the machine, it was necessary to leave an open space between the door jamb and the coke guide. This, of course, allowed a certain amount of coke to drop to the bench and thus become a source of trouble. In order to allow the operator to have access to both sides of the guide, the old design was simply to cut a hole in the rack large enough to enable a man to walk through. This was another source of spillage.

A modern coke guide is shown in Figure 6. In this design the difficulties just mentioned are entirely eliminated and the machines are fully automatic. We now couple the guide to the door machine which provides the traction drive. A rack and pinion drive moves the guide close to the face of the oven so that it engages in the door jamb during pushing and is retracted clear of the oven after the coke is pushed out and before being shifted. Completely automatic doors are provided in the sides of the guide which close during pushing and open when the guide is retracted. These features eliminate spillage during pushing and thus reduce maintenance costs.

When using guides of this design the danger of an error on the part of the operator who might attempt to move the machine while the guide is engaged in the door jamb must be eliminated. To prevent an accident

Figure 5 — Pusher machines usually weigh over 100 tons and run about 75 ft long, 27 ft wide, and 30 ft high.



of this kind an interlocking device is therefore provided so that the machine cannot be moved until the guide has been racked out clear of the ovens.

Coke guides on oven batteries equipped with the so-called high bench are often designed with an inverted U-shaped frame open at the bottom. This is necessary due to the small distance from the oven floor to the bench upon which the guide travels. Rollers mounted on the U-frame carry the movable or racking part of the guide. This rack is usually driven from one side only. Guides used on the low bench type batteries can be more conventionally designed. The greater distance from oven floor to bench permits the movable part of the guide to be mounted on a heavy sub-structure with a rack and pinion drive directly underneath it. The ends of the side plates are rounded and all projections are removed so that the inside of the guide provides a smooth surface over which the coke can be pushed.

The door machine was also originally a manually operated unit. It was pushed into position by hand, the latches engaged by means of a screw device and a hand-wheel provided for moving the door away from the oven. This was a very primitive contraption compared with the machines of today, as shown in Figure 6. They are to a very large extent automatic and require only one operator. The first step forward, of course, came with the addition of the traction drive which enabled the machine to move into position under its own power. Present traveling speeds approximate 250 fpm. Later on designs were introduced to enable the operator to release and tighten the door latches and move the door away from the ovens mechanically.

Some of the more recent designs provide means for withdrawing the door, lifting it and turning it at 90 degrees so that it is in a better position for a man to clean. Along the same lines in order to facilitate the cleaning of the doors, elevators have been installed on the machines. This enables the door cleaner to move to the most convenient position to clean and inspect the door. Heat shields are provided on the elevator to protect the man while working. There is also a safety device on the elevator door so that it cannot be opened until the elevator has been completely lowered. One type of door machine is equipped with two motors, one for travel and one for driving a pump, which supplies oil under pressure to four hydraulic cylinders controlling all other motions of the door machine and the coke guide racking device. The usual accessories are also a part of standard equipment, such as hydraulic brakes, spring bumpers, hand gong, continuous ringing gongs, and lights.

A constant worry to the operators has always been the possibility of misalinement of oven machinery. There have been cases when the pusher machine attempted to push the coke from an oven while the door on the coke side was still in place; a "modus operendi" definitely not to be recommended as it may have highly detrimental effects on the ovens, such as doors forced open, buckstays bent, and may sometimes cause serious damage to the brickwork. The reason why such a mistake can be made is that there is no direct line of vision from the coke side of the ovens to the pusher side. The height of the modern oven and the necessity of locating a great amount of large piping and equipment on top

Figure 6 — The modern coke guide is fully automatic.

of the oven restrict the possibility of being able to sight from one machine to the other.

Many schemes have been devised to assure that the proper oven is being serviced on both sides of the battery at the same time. Some of the devices adopted consisted of bells, signal lights, klaxon horns, periscopes, etc. All of these had the advantage of simplicity but were not infallible as they had to depend on the human element. Smoke, noise, and weather often made these signals of doubtful value.

One modern method of interlocking the machinery, which is now widely used, consists simply of a small pipe for each oven extending from one side of the battery to the other with a flexible hose connection at either end to which the coke guide and pusher machine may be connected. Electric switches actuated by high pressure air pumped into the pipe by a compressor usually located on the pusher machine insure that the pusher ram cannot operate unless the coke guide and pusher machine are connected to the same air line. By limiting the length of flexible hose we can make sure that the machine can service only the correct oven. This system is completely interlocking, and entirely eliminates the possibility of accidents due to misalinement of pusher, door machine, and coke guide.

Another device which has been tried with some success employs the use of a light sensitive cell. The projector lamp is mounted on top of the coke guide and flashes a light beam over to a caesium photo-cell

mounted on top of the pusher machine. The received light is collected by use of a mirror and focused to an image of the distant projector. The image falls upon a narrow slit in front of the photo-cell when the coke guide and the pusher machine are in exact alinement. The leads are carried to an amplifier where the minute current is built up to furnish sufficient power for the operation of the necessary relays, opening and closing the power circuit.

Several types of electric interlocks have also been worked out which make it impossible to start the pusher ram before the other machines are in correct position.

In the early days, as we have already seen in Figure 2, the coke was simply pushed from the ovens onto a bench where it was quenched in place by means of hoses, then loaded into wheelbarrows and dumped into open flat cars.

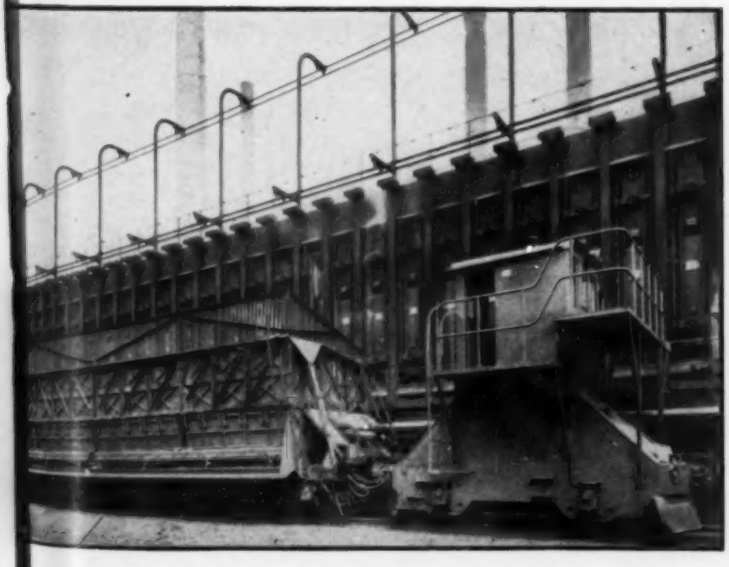
Today the coke is pushed out of the oven through the coke guide and directly into the quenching car. The car carries the hot coke to a quenching station where the coke is thoroughly quenched by sprays of water. From here the coke is taken to a coke wharf where it is allowed to cool.

Specially designed cars have been developed for this duty. The general construction is shown in Figure 7. It is made to resist abrasion and to stand the high temperatures of the hot coke and the shock of sudden cooling when the coke is quenched.

In order that the coke may be discharged by gravity onto the wharf with a minimum amount of breakage, the car is provided with a sloping bottom of the correct pitch.

For its construction, hard cast iron plates supported on a structural steel frame have been used for many years and are still favored by many plant operators. Most new cars are equipped with cast steel gates and cast steel plates over the gates. In the past few years a number of all welded steel cars have been made using abrasion resisting steel plate and are giving very excellent service. The original hand operated gates have now been replaced by either motor driven or pneumatic gates which are opened and closed by the locomotive engineer. The side of the car opposite the ovens and the two ends of the car have steel racks mounted on top to prevent spillage during the pushing operation.

Figure 7 — Both the quenching car and locomotive have been specially designed for their service.



A twenty ton electric locomotive is generally provided to move the quenching car to its various positions. (See Figure 7). The locomotives are usually specified to be of the single truck, two axle type, with a two motor drive. They are rated to give a tractive effort of 10,000 lb, based on 25 per cent adhesion and a speed of 7½ miles per hour. Straight air brakes are provided along with a hand brake for holding the locomotive at standstill. The locomotives are equipped with a semi-magnetic, series-parallel progressive control. There are six regular points for series and five for parallel operation of the controller, but two slower speeds ahead of the first regular series point are also provided. These speeds are obtained by notching the controller back from the first regular point after the locomotive has been set in motion. This gives a slow, smooth start. The controller is equipped with a dead man handle for breaking the control circuits in case the engineer should fall alseep or become otherwise incapacitated. All contactors are solenoid operated. The cab is mounted high on the machine in order that the operator may have a good field of vision. This cab is insulated with asbestos board as a protection against the heat and provided with specially designed windows of heat resisting glass on the side facing the quenching car.

It is the practice generally for the locomotive engineer to signal the pusher machine operator by means of a whistle when the quenching car is in position to receive the coke. As soon as the coke begins to drop into the car, it is slowly moved forward so that the coke is evenly distributed the full length of the car. This assures more thorough and efficient quenching.

We have now discussed the machinery for charging coal into the ovens, removing and replacing of doors, leveling and pushing, and of handling the coke after it has been discharged from the ovens. However, the description of the battery machinery would not be complete without a word about a device known as the reversing machine. See Figure 8.

Since the heating of the modern coke oven battery has become almost an exact science, it is very important that the mechanical aids which control the various cycles of operation are designed for exactness and dependability. The reversing machine, which is entirely automatic, takes care of the reversal of the gas, air, and waste heat valves. It is started and stopped by means of an electrical timing device. Gas is usually burned in one set of heating flues for approximately thirty minutes. At the end of this period the reversing machine automatically changes the flow of gas to the other set, allowing the waste gas to pass through the flues which had previously burned gas. This machine is installed at the end of the battery in a special room which also contains the instruments for controlling the battery heating. The machine is usually operated by an electric motor. Hydraulic machines have also been developed. An auxiliary drive using steam or compressed air is always provided. This emergency drive is used to continue the regular reversals if there is a failure of the electric power. Elaborate precautions are made to guard against failure of the machine to operate for any reason

Figure 8 — The reversing machine is controlled by an electric timing device.

whatever. A signal system sounds a warning if the reversal fails to take place at the correct moment. Remote control stations are installed at various places, such as at the gas holder and fuel gas pressure gages, which automatically cause the machine to move to its neutral position, thus shutting off the gas on the battery in case of danger.

After having made this short study of the various types of coke oven machinery, past and present, we may ask ourselves, "Where do we go from here? What will the machines be like that are now on the drawing boards?" I feel sure that any future development of coke oven machinery will have for its purpose to reduce the number of manual operations and improve working conditions. It has been suggested that we engineers who are engaged in coke oven construction should try to so mechanize the operation that an entire coke oven battery could be handled by one man. From his observation post in a lucite blister high on the side of the battery bin he would control the operations of all the oven machinery by running his fingers over a keyboard like a musician playing an electric organ. We may not see the day of the one man crew, but there is no doubt that due to the ever increasing demands of labor, every effort will be made to carry the mechanization of the oven operations as far as practically possible.

DISCUSSION

PRESENTED BY

JOHN H. KINCAID, Chief Engineer, Wellman Engineering Company, 7000 Central Avenue, Cleveland, Ohio

RAGNAR BERG, Chief Engineer, Engineering and Construction Division, Koppers Company, Pittsburgh, Pennsylvania

E. H. WILSON, Resident Engineer, Jones and Laughlin Steel Corporation, Aliquippa, Pennsylvania

LOYAL R. MILBURN, Consulting Electrical Engineer, 16929 Lawton Avenue, Detroit 21, Michigan

O. L. HENRY, Republic Steel Corporation, Cleveland, Ohio

CHARLES P. BETZ, Assistant Manager, Hanna Furnace Division, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

John H. Kincaid: I would like to ask Mr. Berg his opinion on the use of weigh scales on coal charging cars. They have been used in some cases but by no means generally. Are they desirable or undesirable?

Ragnar Berg: I think they are desirable.

John H. Kincaid: They are not used to any great extent.

Ragnar Berg: Do you have any experience with weigh scales on larry cars?

John H. Kincaid: They generally get clogged up with coal dust and they do not weigh correctly. They have to be kept clean along the knife edges.

Ragnar Berg: If you have any difficulties, I think the scale manufacturer should be able to take care of your trouble. I know in many places where they have scales and maintain them properly they do not seem to have any difficulty.

John H. Kincaid: I would also like to ask about your experience with the welded pusher ram head. I know some have been made.

Ragnar Berg: My information is that they have given quite satisfactory service.

John H. Kincaid: Has there been any trouble from warpage of the weldment in service? Has there been any heat distortion?

Ragnar Berg: No.

E. H. Wilson: We recently put into operation in our Aliquippa works a battery of 106 Koppers ovens, involving some of the latest type machinery. I believe some of the pictures Mr. Berg showed here were taken at that installation.

There has been considerable improvement in the equipment of this type from an operating standpoint. There is still a lot to be desired. This new battery of ovens is served by one larry car, one pusher machine and one door machine equipped with retractable coke guides.

Of course, we have spare larries and spare door machines, but we have only the one pusher machine. The point I am trying to make is that at all times these 106 ovens are served by single pieces of equipment. With this number of ovens being served by a single machine, it is needless to point out the desirability of equipment that will provide continuity of service, as failure of this machine would mean costly battery delays.

We think a lot could be done to improve coal charging. For instance, we believe the charging operations could be made smokeless, better coal feeding could be devised, and some better control of volumetric charging looks highly desirable.

We also think considerable improvement could be made in the pusher machine. The machines we have in operation are of the rigid type whereby the entire weight of the machine as well as the pushing effort is

carried on four wheels rigidly mounted. With slight variations in track alinement, the entire weight of the machine, and at times the pushing effort, is taken on two wheels which results in considerable overloading and high track and machine maintenance.

There is also a lot to be desired in the design of present oven machinery from the standpoint of easy maintenance. More liberal use of tapered fits on wheels, gears, couplings, and so forth, that require renewal from time to time, would greatly facilitate and reduce the time required to make these changes.

We believe considerable improvement in the design of the equipment of this nature would result if the manufacturer would consult with the oven operators and also observe some of the many maintenance problems with which they are confronted.

In closing, I might say that we are all looking forward to the day, as Mr. Berg mentioned, when the complete oven operation can be accomplished by one man with all the controls at his fingertips.

Loyal R. Milburn: I am interested in the interlocking between the guide car and the pusher. Have we developed yet a suitable foolproof interlocking or communication system between two operators so we know when we are lined up?

Ragnar Berg: The one I mentioned in my paper is foolproof. You have an air line for each oven. After connections are made at the coke guide and the pusher machine, compressed air is supplied to the line, which actuates a switch thus energizing the pusher ram electrical circuit.

Loyal R. Milburn: What is your method of connection, just a funnel?

Ragnar Berg: It is a hose line with just a very simple twist connection.

Loyal R. Milburn: In other words, when you go into position, you must hook up the hose line too; is that right?

Ragnar Berg: Yes.

O. L. Henry: May I ask Mr. Berg if that has ever been applied to any oven other than the underjet?

Ragnar Berg: Yes, it has.

O. L. Henry: How do you run your pipes?

Ragnar Berg: Above, along the tie rods or underneath in the battery pad.

O. L. Henry: With the present day labor situation, the subject of coke oven machinery is particularly timely. In the good old days, proper operation was not too difficult of attainment in spite of adverse working conditions. Today, improved working conditions are a must if we are to obtain maximum efficiency from coke oven batteries. The subject of oven machinery so ably presented by Mr. Berg, covers one of the most important factors affecting working conditions.

I have only a few comments to make on this paper as follows:

1. *Pusher machine.*
   a. One builder at least is working on the problem of reduced pusher bridge travel. The idea of having the center line of the door machine and the ram coincide, if successfully worked out, will be a contribution to reduced maintenance and time saving. This innovation cuts the number of bridge operations in half, from four to two per oven operating cycle.
   b. With pusher machines so thoroughly interlocked electrically to prevent accident, the operator is lulled into a sense of lack of responsibility. The door extractor, the ram, and the level bar usually are interlocked so that so long as power is on the bridge motor the other motors will not operate. However the smooth running modern pusher will drift for quite a distance after the power is taken off the bridge motor. Right there we have a hazard. A pusher machine drifting at high speed, the ram controller accidentally on one point, a pusherman not too alert, and we really have a wreck when the ram head reaches the buckstays. This hazard can be eliminated.
   c. The idea of the conveyor located on the pusher machine to return spillage directly to the oven during charging, on the face of it, is good. However, if this device is to be retained it must be more free of breakdowns, it must have more storage capacity, it must overcome the inability to make sure ovens are full on the pusher side ends.
2. *Larry cars.*
   a. Mechanical automatic charging appears destined to general adoption. With washed coals in particular, it is well to have the sequence and timing of the charge beyond the control of the larryman.
   b. The use of the catenary to provide power for the larry car thus eliminating the collector bar load from coke side buckstays, has definite advantages. The catenary can also be applied to the door machine power with the same advantage.
3. *General.*
   a. As machines are provided with more interlocks, more limit switches, more slow downs, and more elaborate control panels the caliber of the electrical department must necessarily improve. Otherwise, delays increase instead of decrease.
   b. In improvement of oven machine design the builders should carefully study the problems of maintenance and inspection. Sometimes in meeting certain other requirements of design, the item of maintenance is complicated even to the extent that the maintenance foreman feels that the designer has forgotten him entirely.

Charles P. Betz: Mr. Berg, in connection with the question Mr. Milburn asked, I would like to say that as long as we have to depend on an electric interlock, it will never be foolproof, and as an operator, I only depend on the interlock as a secondary precaution. We insist that the operators of machinery handle this machinery just the same as if there were no interlock, and it is surprising how often the interlock fails at the same time the human element fails.

Along with that question, Mr. Milburn, you asked Mr. Berg about the success of scales mounted on larry cars. I would like to make the statement that I have been connected with a coke plant in operation for nearly ten years where we have our scales mounted on the larry cars, and we have no more trouble with the scales mounted on the larry cars than we do with the scales on the blast furnace scale cars. They require the same kind of check-up, which we do at periodic intervals, and have experienced no trouble with them. Our material balance also shows them to be accurate.

Design and Performance

OF A REFRACTORY RECUPERATOR

. . . . the vertical tube refractory recuperator is proving itself for soaking pits and slab reheating furnaces . . . . the next possibility is the recuperative open hearth . . . .

By E. G. SMITH, Amsler-Morton Corporation
Pittsburgh, Pennsylvania

▲ THE recuperative principle of preheating air for combustion has been known to industry for many years and has always been regarded favorably because it offers a means by which high thermal potentials and heat economies could be applied to the principal heating and melting processes without reversing the furnace and because it also opens the way to changes in furnace design that would permit more correct application of heat to the work.

When a furnace is reversed, the normal acceleration of the heating or melting process is interrupted and must be re-established before the work of the furnace can proceed. Such interruptions are to the furnace what lost motion is to a machine. However, if the furnace is fired continuously, the correct combination of temperature, pressure, and atmosphere can be established in the furnace chamber and maintained from start to finish of the process. This means that a constant heat potential can be maintained and with it, a constant acceleration of the process.

In the conventional reversing furnace, the ports must serve alternately as burners and as waste gas outlets and must, therefore, be a compromise between a properly designed and located burner and a properly designed and located waste gas outlet. With recuperation, the burners and waste gas ports can each be designed according to its principal function and each can be located with full consideration to the correct application of heat to the work on the furnace hearth.

Although it had these and many other potential improvements in furnace operation and design to accelerate its development, the recuperator did not achieve the results desired of it until within the past decade. Prior to that time, it would have been hard to explain why a piece of equipment with so many desirable possibilities could not establish itself but from the vantage point of today's experience, we can see that in the effort to eliminate leakage, obtain a high rate of heat transfer and satisfy certain pressure conditions that were thought to be essential to good burner operation, several very logical principles of construction and operation were completely overlooked or disregarded.

First, if a recuperator is to achieve the maximum recovery from the products of combustion, it must be installed in close coupled relationship to the furnace and, therefore, must be made of materials that are capable of withstanding practically the same temperatures that exist in the furnace itself. Second, expansion and contraction of the structure due to temperature change must be automatically compensated for without stressing the recuperator parts or opening joints. Third, the heat exchange surfaces must be self-cleaning so that materials carried in the waste gases will not form deposits which act as insulators to retard heat flow.

These principles are embodied in the vertical tube refractory recuperator which was originally developed for the glass industry where it was widely used on continuous melting tank furnaces, day tank furnaces, and pot furnaces. The temperatures and working conditions in these furnaces do not differ widely from those encountered in soaking pits, heating furnaces and open hearths, and as a result, the general design and many details of construction of this recuperator had been fully proven when the first installation for the steel industry was made in connection with a soaking pit at Mingo Junction, Ohio in 1936.

The general design of this recuperator is based upon the counterflow principle and it makes use of the natural laws of convection to promote the flow of air and waste gases. See Figures 1 and 2. The waste gases leave the furnace and enter a large distributing chamber or manifold above the tile assembly and flow downwardly, as they are cooled through straight smooth walled tubes

Presented before AISE Annual Convention, Pittsburgh, Pennsylvania, September 25, 1947

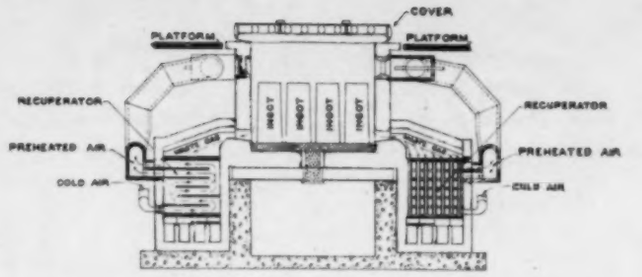


Figure 1 — Typical design of recuperative soaking pits equipped with vertical tube refractory recuperators showing paths of waste gases and air through the tile structure.

to the waste flues. Cold air is delivered to the recuperator by a simple low pressure blower and enters the lowest level of the tile assembly through a series of openings extending full width of the enclosure. From the point of entrance, it follows a shuttle path upward, as it is heated, to a collecting flue and thence to the burner.

The assembly is made up of four principal tile shapes plus the shapes for the top and bottom seal courses. All are so designed that the octagonal tube tile can be evenly spaced in staggered rows to form a rectangular assembly varying by 12 in. increments in width or length. See Figure 3. The connecting flange for the tube sections plus the small filler tile and spacer tile interlock to form the baffle shelves that guide the air through its upward shuttle path. Openings in the shelves to permit the air to rise from one pass to the next are provided by the simple expedient of omitting the filler tile at the proper points. As the air temperature increases, multiple shelved passes are formed in order to provide the correct areas.

The seal tile, flange collars, spacer tile and filler tile are made of first quality and super-duty material by ordinary manufacturing processes because the service required of these parts is not unusually severe or critical. However, the tube sections which form the principal heat transfer elements and also act as columns which support the structure required not only the development of a suitable material but also the development of a manufacturing technique.

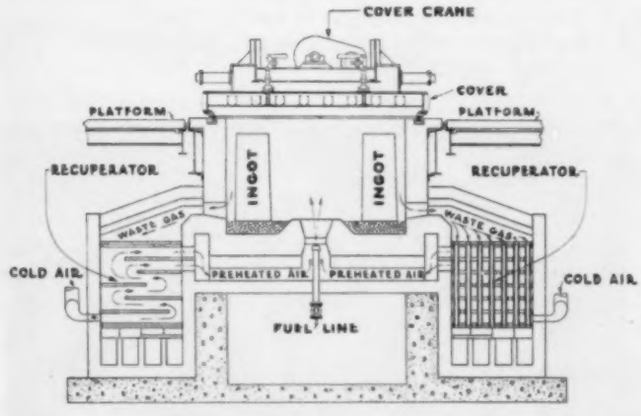
The material for the tubes consists of equal parts of raw clay and burned clay. The raw clay component is a mixture of several high alumina Missouri and Georgia clays carefully blended to obtain consistent refractory properties. To this raw clay mixture is added 100 per cent by weight of hard burned calcined fire clay finely ground and screened. This material is formed by slip casting in plaster of Paris molds into octagonal shaped tubes approximately 12 in. long by 4¼ in. inside across flats and ½ in. in wall thickness. This process produces a stable refractory body of low porosity and uniform density with high structural value and resistance to spalling and checking.

The assembly is laid up in high temperature cement, as shown in Figure 4, and bonded to the enclosure walls only around the periphery of the bottom seal course. The intermediate shelf tile merely rest against the enclosure walls to hold the assembly in alinement and the top seal course is flexibly bonded to the walls so that the air cannot escape into the waste gas distributing manifold. This principle of construction allows the entire assembly to rise and fall as the tubes expand and contract in response to temperature changes without stressing any of the refractory parts. The joints between the top and bottom ends of the tube sections and the flange tile are horizontal and cannot open when the tubes contract because the weight of the structure superimposed on each joint always forces the joint tightly closed regardless of temperature conditions.

The vertical tube construction automatically provides the self-cleaning feature necessary to keep the heat exchange surfaces free of insulating deposits. Each tube forms a straight smooth walled channel for the flow of waste gases, and materials carried from the furnace such as ash, coke braize particles, etc., find no place to lodge. The products of combustion from open hearths and glass melting furnaces carry substances which adhere in stalactite formations to the inside of the tubes. For installations of this type, a plugged opening is provided in the arch above each tube through which suitable tools and lances can be inserted for periodic cleaning. Dust which may be picked up by the air stream causes no difficulty because it is generally dry and will not adhere to the vertical outer surfaces of the tubes. Furthermore, the velocity is so low and the flow so turbulent that any material carried in the air stream is deposited on top of the horizontal bottom seal course.

Recognition of the basic problems involved in the construction and operation of a high temperature recuperator and the application of known materials and simple natural laws to their solution resulted in the development of a design that could be closely integrated with the furnace structure. To illustrate this point, we have the types of furnaces shown in Figure 5. One is a vertical fired soaking pit with a recuperator located at each end below hearth level. Another is a batch type reheating furnace fired from both ends with a recuperator chamber under the hearth at each end. A third is a continuous reheating furnace fired from the cold end with the recuperator located below the hearth at the charging end.

Figure 2 — Another design for a soaking pit equipped with a refractory recuperator. This pit is bottom fired.



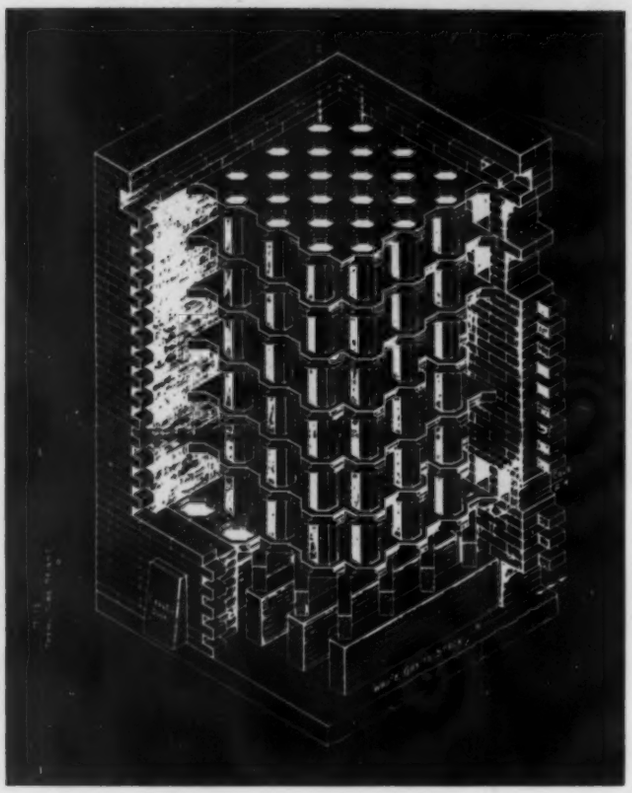


Figure 3 — Cut-away view of recuperator chamber showing method of assembling tile to permit free vertical expansion and contraction of the tubes. Only the bottom shelf is bonded to the enclosure walls.

Although these furnaces differ widely in design and method of operation, they are all three characterized by the same features of recuperator application. First, the furnace and recuperator form a self-contained unit with waste gas flues between the furnace and recuperator, preheated air flues from the recuperator to the burners and the burners themselves included within the principal refractory structure of the furnace.

This closely integrated construction is adopted to the greatest extent possible to reduce heat losses and obtain the maximum possible air preheat temperature at the burner. Second, the burners themselves consist of a calibrated refractory port block and a hot air receiving chamber, both of which are contained in the furnace wall and a simple tube of heat resisting material through which fuel is introduced into the air stream. This construction is adopted because of its simplicity and because the conventional burners having internal metal parts exposed to high air temperatures deteriorate very rapidly. This is not because of high air temperature alone, but more from the lack of cold air to dissipate the heat radiated from the furnace to the burner parts. Third, no exhauster or devices for measuring and controlling the flow of air are interposed between the recuperator and burner and as a result, it is not necessary to provide by-passes or bleeder valves to reduce the air temperature for the protection of these devices.

Fourth, the flow of air is measured and controlled in the piping system between the fan and the recuperator by conventional means that are responsive only to the measured requirements of the furnace. No provision is made for protecting the recuperator against high temperature because, as mentioned earlier in this paper, the refractory materials are always selected to withstand the temperatures to which they will be exposed and therefore, do not require such protection. Furthermore, it is not logical to invest in a device to salvage waste heat and then, after salvage is accomplished, waste part of the heat to atmosphere through a bleeder valve, or dissipate its potential value by reducing the air preheat temperature.

The vertical tube refractory recuperator has been used in connection with all of the principal industrial fuels and has operated under heating practices ranging from that of continuous slab heating furnaces to heating alloy ingots which required cooling the soaking pit to black before the ingots were charged. Under these conditions, its performance as a heat exchanger has been established by air preheat temperatures ranging from 1300 to 1850 F and stack temperatures ranging from 700 to 1200 F for 2400 F furnace operating temperatures.

Soaking pits equipped with this recuperator have heated 95 ton charges of 25 × 25 in. bank cold ingots with 1,050,000 Btu per ton, and several large soaking pit installations have recorded monthly overall fuel rates of 450,000 Btu per ton for ingots with 3 hours track time and a relatively small percentage of cold and alloy ingots.

Although these fuel rates are low, they do not always justify the cost of recuperation except where fuel costs are high. There are other sources of revenue which also help to justify the investment in recuperation. The first and probably the most important source of revenue from typical recuperator installations such as those illustrated in Figure 5 is the increase in the heating capacity of the furnace. Part of this gain is, of course, due to the fact that the furnace is fired continuously and the high air preheat temperature results in a high temperature potential. But for the most important factor contributing to the increase in production, we must again look to the material from which the recuperator is made and to the manner in which it is built into the furnace structure.

Refractory materials do not have the high coefficient of heat transfer that is associated with some other heat

Figure 4 — A vertical tube recuperator under construction. The horizontal joints at the ends of the tube sections are sealed by the weight of the superimposed structure.

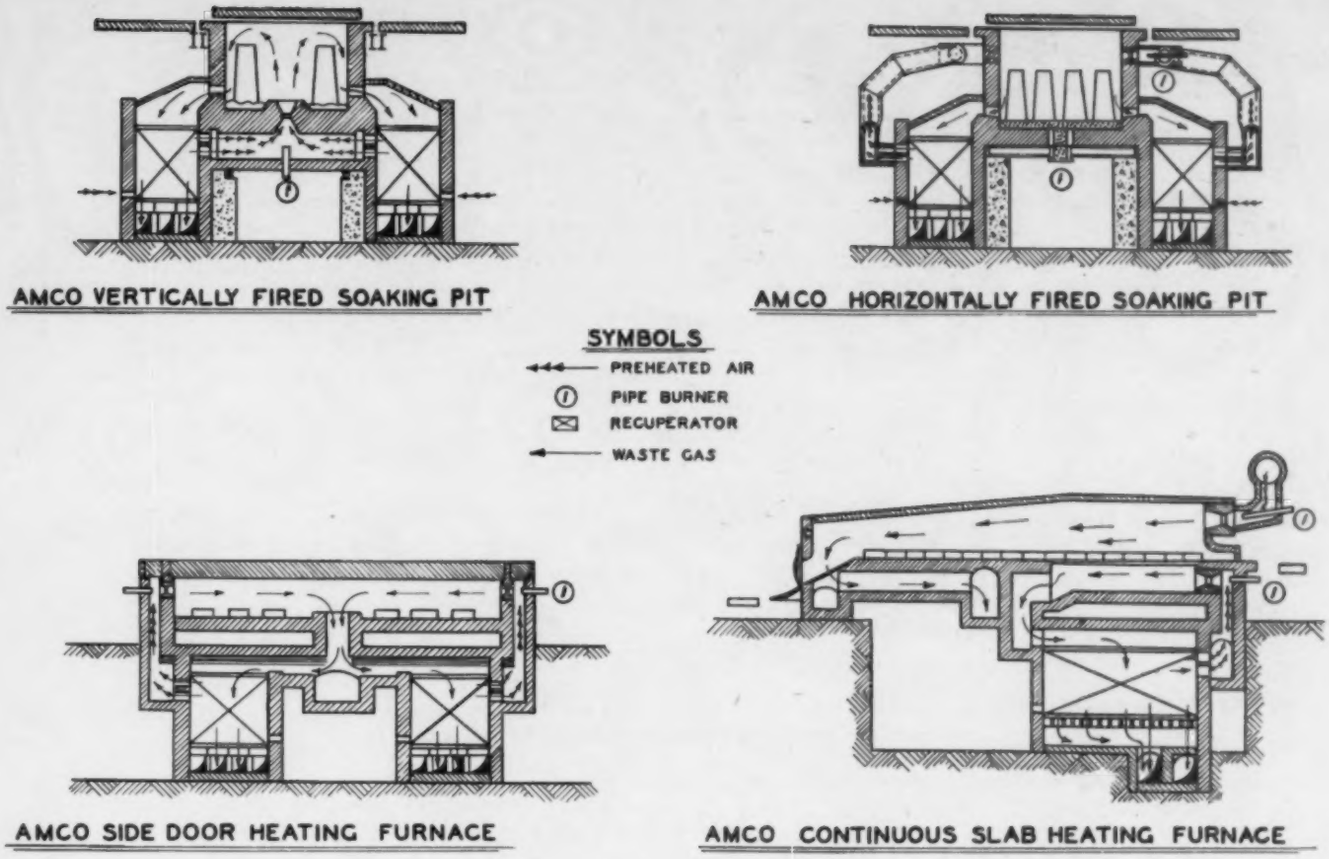


Figure 5 — This illustration shows a uniformity in design of heavy duty recuperative furnaces. Vertical tube recuperators are always closely integrated with furnace structure to give high preheat temperatures at the burners.

exchanger materials, but they do have a high heat storage capacity which causes the integrated recuperator structure to act as a thermal flywheel stabilizing air preheat temperature. This property is illustrated by the curves in Figure 6 which shows a 23 hour temperature history of a soaking pit equipped with the refractory tile recuperator and burning cold blast furnace gas. Although the furnace temperature varied through a range of 350 F, the preheated air temperature remained relatively constant at 1830 F to 1870 F except for a peak of 1950 F near the end of a soaking period. This indicates that the heat stored in refractory material while the furnace was at maximum temperature sustained the air preheat temperature at the start of the succeeding cycle, and as a result, flame temperature and heat potential were to all practical purposes stabilized for a 23 hour period. This accelerated the initial rate of heating for each charge and maintained furnace temperatures to the point where satisfactory rolling temperatures and production were obtained for the first time with cold blast furnace gas.

Had these recuperators been built of material having a high heat transfer coefficient and low heat storage capacity, they would have responded to changes in furnace temperature and the preheat curve would have paralleled the furnace temperature curve. The flame temperature at the start of each heating cycle would have been low and initial acceleration of heat absorption would have been impossible.

In the foregoing paragraphs, we have shown how the uniflow system of firing and constant high air preheat temperatures accelerate the rate of heating, and that an increase in furnace production is the natural result of this acceleration. Of equal importance from the standpoint of production rate and also return on investment is the increase in product yield that is obtained as a result of these same two factors.

Scale formation is a function of furnace temperature, furnace atmosphere and heating time. In the modern industrial furnace, temperatures are usually dictated by characteristics of the product or rolling practices and are precisely regulated to these predetermined values. Furnace atmosphere is also precisely regulated but more important from the standpoint of scale formation is the fact that where high preheat temperatures are used, less excess air is required to burn the fuel. This reduction in available oxygen in the furnace atmosphere plus the reduction in heating time retards scale formation and reduces metallic losses in the high temperature recuperative furnace by approximately 1 per cent below that in direct fired and low preheat installations and by as much as 2 to 3 per cent below that in furnaces where washing and port marking are prevalent.

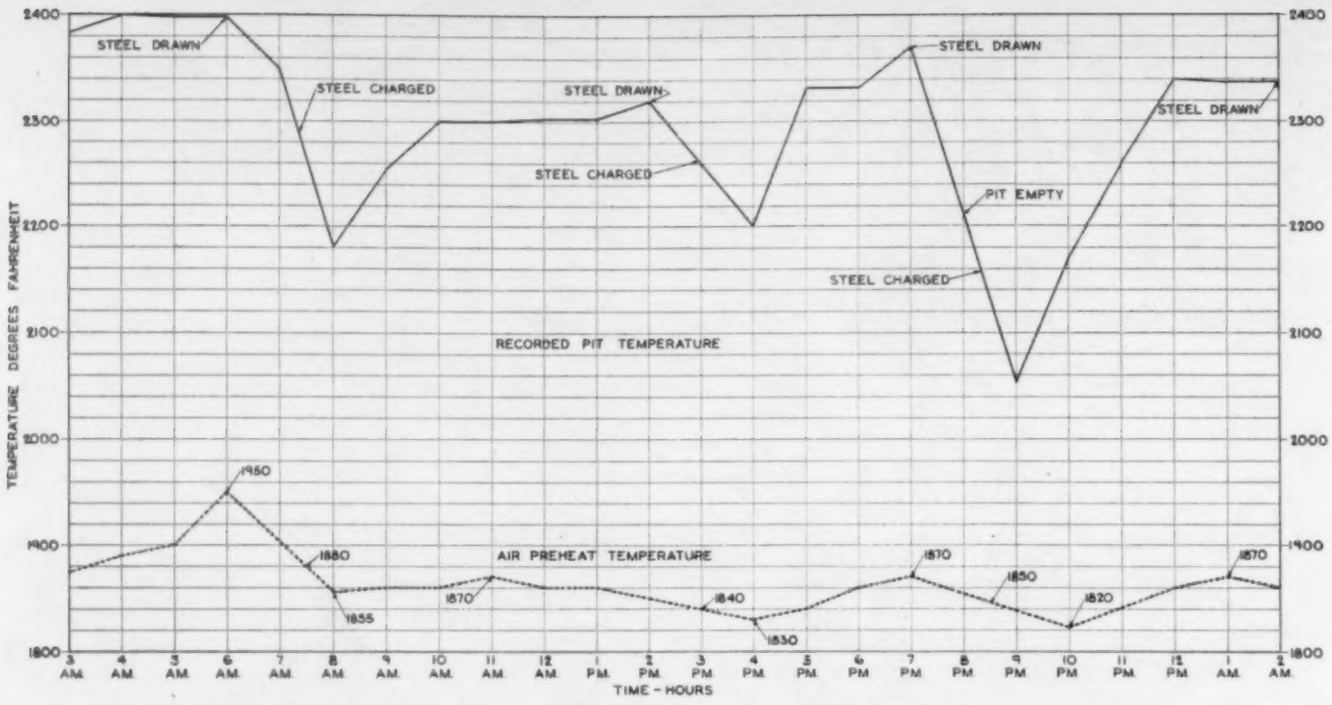


Figure 6 — Chart showing 23 hour temperature history of a soaking pit. Note relatively constant air preheat temperature resulting from heat stored in refractory tile.

Some operations by reason of local conditions require a heavy scale to reduce surface defects and if so, there is no factor in the high temperature recuperative installation that will defeat this purpose.

Comparative data on batch type operations in non-recuperative furnaces and furnaces equipped with the refractory tile recuperator indicate that the increase in production due to the uniflow system of firing with a sustained high air preheat temperature amounts to 15 per cent or more. This increase in production is roughly equivalent to one additional furnace unit in the space occupied by six and when we consider, for example, the cost of a seventh row of soaking pits or a seventh reheating furnace with the necessary additional building and foundations, then the justification of recuperator investment becomes less difficult.

Table I is a tabulation which shows the monthly overall performance of direct fired soaking pits in comparison with the monthly overall performance of recuperative soaking pits. Both were identical in size and construction and were equipped with modern sealing covers and a modern system of automatic controls. However, eight of the pits were equipped with commercial cold air burners of modern design and twelve were equipped with clay tile recuperators and used the high temperature burner construction shown in Figure 2. These data indicate that the recuperative pits heated 15.3 per cent more steel and used 40 per cent less fuel than the non-recuperative pits.

Table II is a tabulation showing the monthly overall performance of a direct fired reheating furnace compared to the performance of recuperative reheating furnaces. These furnaces were similar to the design shown in Figure 5 except that the two hearths were

TABLE I

Comparison of Direct Fired and Recuperative Soaking Pits

	Tons of ingots heated average per pit	Btu per ton average for month
First month		
Recuperative pits	6,414	683,000
Direct fired pits	5,561	1,160,000
Gain due recuperative pit	853	477,000
Percentage gain	15.3	41.1
Second month		
Recuperative pits	6,081	650,000
Direct fired pits	5,106	1,236,000
Gain due recuperative pit	975	586,000
Percentage gain	16	47.4

TABLE II

Comparison of Direct Fired and Recuperative Reheating Furnaces

	Tons heated average per hearth	Btu per ton average for month
First month		
Recuperative furnaces	3,523	1,599,000
Direct fired furnace	2,361	2,835,000
Gain due recuperative furnace	1,162	1,236,000
Percentage gain	48.8	43.6
Second month		
Recuperative furnaces	3,745	1,733,000
Direct fired furnace	2,621	3,234,000
Gain due recuperative furnace	1,124	1,501,000
Percentage gain	42.8	46.4

separated by a transverse division wall which made each unit in effect two furnaces and all were charged with hot slabs which were reheated for a plate mill. All of the furnaces were of identical size, construction, and design and all were equipped with modern doors and modern automatic control systems. Two of the furnaces were equipped with clay tile recuperators and commercial insulated burners for hot air and one was equipped with standard cold air burners of modern design. In this case, the comparative data indicate that the recuperative furnaces heated 45 per cent more steel per hearth than the non-recuperative furnace and used only 44 per cent as much fuel.

These two tables emphasize very strongly the fact that modern furnace construction combined with a modern combustion system and a modern automatic control system cannot be considered a substitute for recuperation. The effect of these devices on furnace performance ends when the products of combustion leave the furnace and the work of the recuperator begins when it receives these products and the sensible heat that would otherwise be lost to the process. To the economies gained through the use of modern construction and modern accessories can always be added the economies gained through the use of recuperation and the extent of this additional saving depends on the type of recuperator used and how well it is integrated into a self-contained unit with the furnace.

The life expectancy of the clay tile recuperator can be conservatively estimated at five to six years although many have been in operation for nine years without being repaired or cleaned. Some air will be lost into the waste products in the tubes if sufficient pressure differential is impressed on the thin walls. This leakage factor was established at something less than 10 per cent for the normal operating differential of 0.15 inches water column on an installation comprising eighty recuperator chambers. The clay material and the principles of construction preclude progressive deterioration such as occurs in metals and in refractories which react at high temperatures. The low leakage factor, therefore, remains constant for long periods and consequently can be readily compensated for with respect to its effect on combustion.

To justify the cost of recuperation is a relatively simple matter when all of the operating savings are taken into consideration and the net cost accurately determined. Let us take as an example the soaking pit illustrated in Figure 1 and assume that the recuperators are omitted. As a result, the flues and the waste gas dampers must be capable of withstanding temperatures of 2100 F or more. To avoid high maintenance costs and provide reasonably comfortable working conditions in the areas about the furnace, the flues must be heavily constructed and well insulated and the dampers must be of the water-cooled, sliding type which requires a relatively complicated and expensive operating rig. These dampers and operating mechanisms are always very active sources of maintenance costs. In contrast with this expensive construction, the flues for the recuperative furnace need to withstand temperatures ranging from 700 to 900 F for rich fuels and approximately 1200 F for a very lean fuel and, therefore, a circular steel plate duct lined with 2½ in. of firebrick and 1½ in. of insulating block is all that is necessary to conduct the waste gases to the stack. The dampers are simple cast iron or low grade heat-resisting alloy butterfly valves which require little or no maintenance. The difference in the two types of flue construction and damper installations must be deducted from the gross cost of the recuperator installation in order to arrive at its net cost for amortization.

Let us now take as a second example a soaking pit installation to serve a mill that rolls 120,000 tons of low carbon ingots per month all of which are charged at two to three hours track time. The new pits will replace ten rows of regenerative pits and we find that pit size, ingot coverage, etc., will permit a normal heating rate of 14,000 tons per month per row in recuperative pits. This establishes the recuperative installation at 10 two-hole rows which includes one row for standby, additional ingot coverage or to heat cold

TABLE III

Comparison of Operating Costs

	10-Two hole rows recuperative pits (1500 F air preheat)	12-Two hole rows direct fired pits (no preheat)	Existing pits (reversing)
Operating costs — per ingot ton			
1. Fuel at $0.20 per mm Btu	$ 0.09	$ 0.20	$ 0.25
2. Maintenance	0.025	0.05	0.12
3. Labor	0.07	0.07	0.187
4. Metallic losses at $20.00 per ingot ton	0.20	0.275	0.40
5. Coke, power, water, etc.	0.02	0.03	0.05
6. Recuperator rebuild — 5 years	0.021	.....	.....
Total cost per ton	$ 0.426	$ 0.625	$ 1.007
Monthly cost at 120,000 tons per month	$51,120.00	$75,000.00	$120,840.00

	Amount	Per cent
Monthly saving against present operation		
For recuperative pits	$69,720.00	57.8
For direct fired pits	45,840.00	37.9
Saving — recuperative pits against direct fired pits	$23,880.00	31.85

ingots that occur, for many reasons, in operations of this sort. On the same basis, 12 two-hole rows of direct fired pits are required to the cost of which must be added for comparative purposes, the cost of 20 per cent more building and foundation work and possible alterations to the existing track layout.

Now let us refer to Table III which shows the estimated operating costs of the two types of pit under consideration and the cost of operating the existing installation. The summary of these comparative costs shows that the recuperative pits will save $69,720.00 or 57.8 per cent of the present monthly operating costs and the direct fired pits $45,850.00 or 37.9 per cent of the present operating costs. If we assume for present purposes that the total investment is the same for both installations, making the fixed charges equal, then the direct fired installation will require about 32 per cent more time to amortize the investment than the recuperative furnace.

If a decision is made in favor of the direct fired pits, their operation will cost $23,880.00 per month in potential savings that would otherwise accrue through the use of the recuperative pit. Under other circumstances, a recuperative installation could cost considerably more than a direct fired installation and we might dispose of the matter by saying that eventually the user will pay in potential savings for the most efficient installations available. But this viewpoint is misleading because the direct fired furnace is still inefficient after the recuperative furnace has been paid for. To all practical purposes, the potential savings that are lost through the use of direct fired or low preheat installations are, like depreciation and interest, a fixed charge that should be deducted from the gross savings in order to arrive at the net operating saving for amortization.

We have shown that the vertical tube refractory recuperator utilizes an ordinary material that is always readily available, and simple principles of design and construction to obtain a self-sealing and self-cleaning structure that remains operable over long periods under temperature conditions that were hitherto regarded as impossible for a recuperator. We have also shown that by properly integrating this recuperator and the furnace into a self-contained unit which we have referred to as the recuperative furnace, preheat temperatures are achieved result in outstanding economies for the furnace as a unit.

The next logical advance in recuperative furnace design is the recuperative open hearth. It is true that there are still a few problems to be solved in developing the recuperative open hearth that did not occur in the development of the recuperative heating furnace. But when you visualize the effect which a sustained preheat of 2100 F and uniflow firing would have on production rates, maintenance costs and fuel rates, then the solution of these problems appears to be worth any amount of effort and money required for their solution.

DISCUSSION

PRESENTED BY

MARTIN J. CONWAY, Steel Industry Consultant, Stacey-Dresser Engineering Company, Gap, Pennsylvania

H. S. HALL, Fuel Engineer, Lukens Steel Company, Coatesville, Pennsylvania

Martin J. Conway: The author has evaluated the basic reasons for determining the type of heat recovery system best suited to a particular furnace operation. Personally, I am interested in Mr. Smith's closing reference to the possibilities of a recuperative open hearth furnace and believe he is on safe ground, especially so, as the use of oxygen for open hearth combustion is becoming a distinct possibility for the future.

A maintained preheat of 2100 F or even less used in conjunction with oxygen will provide sufficient heat head to speed up the tons per furnace hour, 20 to 30 per cent, and, because of the continuous firing, allow the furnace to be designed in such a manner as to minimize refractory abuses or, at least, confine them to the outgoing end and part of the furnace roof; thereby utilizing the inherent longer life of recuperators compared with checkers.

Means are available to adequately protect the furnace roof by using preferably a suspended roof which is air cooled by forcing finely divided streams of cold air, under low pressure, through it in such volume as to provide a thin blanket of cold air on the underside of the roof, thereby providing a protective oxidizing atmosphere for the roof refractory which, of course, is more beneficial than the present prevailing reducing atmosphere. The exit end of the furnace can be suitably protected by any of the conventional methods with the result that the melting chamber and ends of the furnace will retain their proportions for a much longer period than is now general practice, especially on oxygen practice.

The recuperator design described can be adjusted to allow for minimum deposition of the products carried over in the waste gases, and perhaps, in cases where the oxygen consumption is relatively heavy, by-pass a certain portion of these gases to waste heat boilers for steam generation.

H. S. Hall: About five years ago we installed a new recuperator on a side door heating furnace in our 112 in. mill. Prior to the installation of this new recuperator we were getting preheated air temperatures of 400 to 500 F, and our Btu per ton were usually well over 5 million. The furnace heated very slowly but gave us fair heating. I wish to stress this point, that nothing else was done to the furnace at this time except install the new recuperator and new burners. The furnace proper was not rebuilt.

After the installation of this new recuperator we got preheat temperatures of 1600 F, and have had fuel economies well below 2.5 million Btu per ton. These fuel figures are for all cold steel and include light up fuel over week ends. This furnace is fired with either natural gas or oil.

I believe the above shows clearly the benefits of high preheated air temperatures.

NATIONAL TUBE BUILDS NEW COKE PLANT AT LORAIN

▲ COKE making capacity at the Lorain works of National Tube Company in Lorain, Ohio, has been increased to a total of 1,650,000 net tons annually by the addition of new coke ovens with an annual capacity of 800,000 net tons (Figure 1). The improvements include enlargement and modernization of coal and coke handling facilities, the construction of three new coke oven batteries of 59 ovens each, and numerous changes to facilities for recovery of coal chemicals.

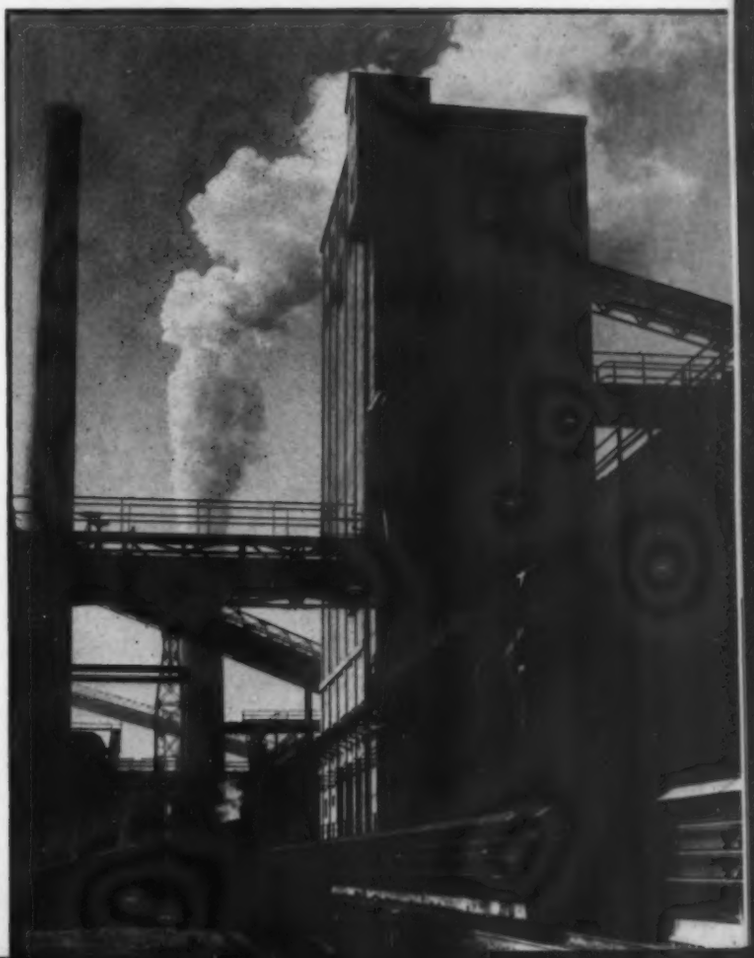
Improvements in coal and coke handling facilities were made by installation of a rotary car dumper, doubling the number of mixing bins to increase coal mixing capacity from two types to four types of coal, installation of gravimetric mixers to replace volumetric mixers for crushed coal, adoption of the use of conveyor belts in conjunction with the car dumper to replace the old stocking method which employed a shuttle car and pits thus improving stocking and reclaiming operations, concentration of a coke screening station designed to load coke into hopper cars of trucks, and facilities for splitting coke braize into pea coke for commercial sale and coke dust for use in soaking pits and the sintering plant.

The new coke ovens consist of three batteries, each battery composed of 59 underjet-fired, low-differential, regenerative ovens. They are designed for firing with coke oven gas and may be underfired at some future time with blast furnace gas by the installation of suitable auxiliary equipment.

Recovery of coal chemicals has been improved by installation of electrical precipitators for removal of tar from the coke oven gas, adoption of a process for production of ammonium sulphate that allows control over crystal size to replace old-style saturators, installation of parallel control on exhausters, use of a continuous carbon disulphide column for removal of this hydrocarbon compound from light oil, installation of a continuous benzol column to produce inhibited motor benzol replacing the batch still formerly used, use of a continuous residue removal column instead of a blow-over still, and adoption of a distillation method for producing naphthalene.

The new coal and coke research laboratory that forms

Figure 1 — Coke side of the new batteries of coke ovens at the Lorain works of National Tube Company, a United States Steel Corporation subsidiary. These three new batteries of 59 ovens each have an annual capacity of 800,000 net tons.



an important part of the program is devoted to research and development of new products and to determination of the properties of coal used and coke produced in controlling operations. It features a 13½ ton capacity coal testing oven for determination of expansion properties of coal.

Simultaneously with enlargement of facilities for making coke and coal chemicals, the problem of increasing stocking devices, storage facilities and coal preparation and handling equipment arose. In brief, this problem was solved by the installation of a rotary car dumper which is capable of handling 30 cars per hour and is expected to handle 20 cars per hour under normal operating conditions, replacing unloading methods which formerly could handle only 65 cars in 8 hours. The number of available mixing bins has been increased so that the coal handling system can blend four types of coal instead of two as formerly. Gravimetric mixers were installed for the crushing of coal replacing volumetric mixers previously used.

High and low volatile coals from mines owned by the United States Steel Corporation furnish the bulk of the coal for producing coke at Lorain works. With the new coke ovens at normal operating rate, approximately 6300 tons of coal per day will be handled. Normally the coking coal mix is made up of equal amounts of high and low volatile coals.

The approximate dimensions and capacity of each of the 277 new coke ovens are as follows:

	Cold	Hot
Length, overall	41 ft, 6¾ in.	42 ft, 1½ in.
Length, between doors	39 ft, 0 in.	39 ft, 4¾ in.
Height of oven chamber	10 ft, 0 in.	10 ft, 1⅞ in.
Height to coal line		9 ft, 1 in.
Width of oven, pusher side	17 in.	16⅝ in.
Width of oven, coke side	21 in.	20⅝ in.
Width of oven, average	19 in.	18⅝ in.
Taper		4 in.
Center to center distance of ovens		3 ft, 7½ in.
Number of vertical heating flues	29	
Cubical content to coal line	555.6 cu ft	
Coal charge (based on coal weighing 48 lb per cu ft as charged)	13.3 net tons	
Normal coking rate	1.1 in. per hr (16 hr, 56 min)	
Coke produced per oven per 24 hr	12.46 net tons	
Coke produced per day in new ovens	2206 net tons	

Pusher bridge	375 feet per minute
Ram (forward stroke)	90 feet per minute
Ram (retracting stroke)	115 feet per minute
Leveler bar	130 feet per minute

The ovens are of the four-divided type, each consisting of two outer zones and one double inner zone. They are designed for firing with coke oven gas having a calorific value of 500 to 550 Btu per cubic foot at present, and may be underfired with blast furnace gas at some future time by the installation of suitable auxiliary equipment. Provision has been made in plant layout and design for the construction of three additional similar batteries of ovens at some later date.

The regenerators of the ovens are filled with slotted types fire clay checker brick. The bus flues which run beneath the checker chambers are built up independently of the pillar walls. They are lined with fire clay shapes, with joints staggered both horizontally and vertically with the joints of adjacent brickwork. Steel flashing plates in short lengths having overlapping joints are provided on all bus flue surfaces that are exposed to gas counterflow. Heating walls are constructed of tongue and groove liner and header silica shapes. The headers are interlocked not only with each other but also with the liners.

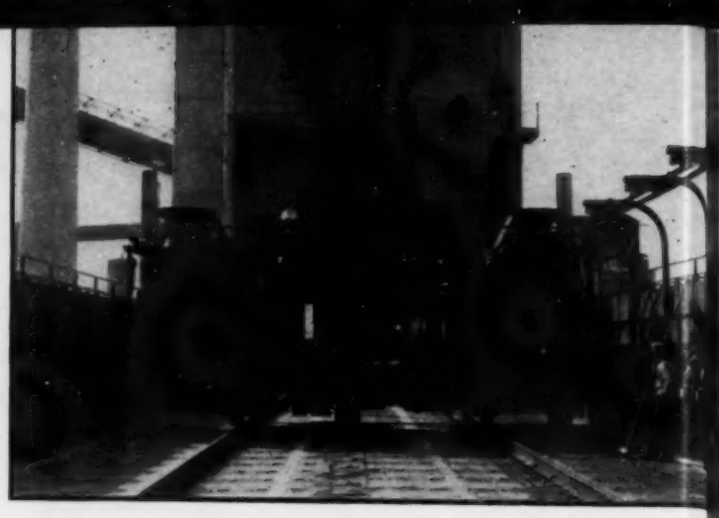


Figure 2 — Larry car dumping coal into an oven forming one unit of the three batteries recently placed in operation at the Lorain works. Coal is fed from the three cylindrical hoppers of the car at a controlled rate by a rotating-table feeder under each hopper.

Coke oven gas under regulated pressure is delivered through the main coke oven gas manifold to the underjet system, which is located below the concrete deck. The underjet system comprises the individual wall manifolds with reversing cocks, and connections to the individual flues, each having a metering device. This metering device consists of an orifice accurately bored to ½-inch diameter, and a removable, concentrically located pin. Gas flow at any desired rate is obtained by changing the nozzle pins, which are of different diameters, in steps approximating 2½ per cent increments in the gas rate.

A waste gas flue is located on the coke side of each battery, with a connecting flue to the chimney. There is one chimney 9 feet in diameter by 250 feet high for each battery.

Oven door jambs of the self-sealing type are installed on both the pusher side and the coke side of each oven. A self-sealing oven door is installed on the pusher side and the coke side of each oven. These doors are of welded steel construction, with a flexible steel sealing plate and renewable sealing strip. A self-sealing type leveler door with spring arrangement for exerting pressure on the sealing edge is provided on each pusher side door. The leveler door frame is bolted to the oven door frame.

Two standpipes for each oven (one on each side of the battery) convey gas from the oven to the gas collecting mains. They control carbon build-up inside the oven roof, eliminate considerable smoke during charging, and improve gas yield as compared to single standpipe practice. A U-shaped gas collecting main on each side of the battery has a gross area of approximately 23 square feet at the crossover gas suction main offtake. Each main has the capacity to carry the entire gas load of one battery. A bleeder stack with a liquor sealed valve is located at each end of each collecting main section, the stacks being 20 inches in diameter and 20 feet high.

Welded to the collecting main is a 13-inch diameter

liquor sealed valve body, with a flange for bolting to the elbow of each standpipe. Each valve body is fitted with a pressure lubricated valve, having an opening 2 inches wide by 6 inches long, and inspection hole with plug, and a flushing type liquor spray nozzle.

One 42-inch diameter crossover main at each battery connects the pusher side collecting main with the offtake main over the quenching track, and is fitted with a regulating butterfly valve assembly, four flushing liquor sprays, and inspection holes having cast iron plugs. A 42-inch diameter offtake main from the coke side collecting main to the suction main south of the coke quenching track is provided with regulating butterfly valve assembly, two liquor flushing spray nozzles, and inspection holes having cast iron plugs.

The suction main consists of 42-inch, 54-inch and 60-inch pipe from the offtake mains to the manifold at the inlet side of the new primary coolers. The manifold, 60 inches in diameter, has connections to the suction main and each primary cooler.

Air intakes are in the pusher side alleyway floor at the end of each battery, for admitting combustion air to the combustion air ducts. The air intakes are covered with welded steel grating. A manually operated butterfly damper has been provided for each end of the combustion air duct at each battery. These dampers are of the vertical type, operated from the pusher side alleyway.

One twin reversing valve for waste gas is located on the coke side for each regenerator. The valves are of the vertical type, with waste gas ducts connected to the waste gas flue. Flow is controlled by a butterfly valve. Each regenerator has two valves for reversing air, with hinged lids for admitting or shutting off combustion air, and finger bars for regulating flow of air.

The waste gas valves are actuated by a reversing rod located in the coke side alley; the air valves are operated by the return rod located in the basement, both rods being connected to the reversing machines for mechanical operation.

Each battery has a mechanism for actuating the waste gas and air reversing valves and the coke oven gas reversing cocks. Fuel gas reversing cocks are actuated by a pair of rods paralleling the fuel gas main in the basement, the return rods being located below the gas cocks. The reversing cocks are lubricated by a manually-operated pressure system, operated from a central station.

Two combination coke pusher and leveler machines have been provided for the three batteries of ovens. Approximate maximum operating speeds of the component parts of the machines are as follows:

A coal charging car with capacity for 13.3 net ton ovens operates over each battery (Figure 2). Each car has three hoppers fitted with revolving table bottoms for delivery of coal to the ovens and mechanism for operating the coal bin gates when charging coal to the car. Each car has a bridge speed when loaded of 380 feet per minute maximum; when empty, a speed of 420 feet per minute. Frames are of riveted construction, supporting the cylindrical hoppers, motors, operating cab and platform.

Six door machines are employed, three for service on the coke side and three for service on the pusher side of the batteries. The machines are duplicates, and are of the hydraulically operated type, with swinging heads. Each machine consists of a motor driven underframe on which is mounted hydraulically operated mechanism for unlatching, removing and swinging the doors 90 degrees for cleaning. Bridge of each door machine operates at a maximum speed of 300 feet per minute. Each operation of the hydraulic cylinder mechanism requires about 8 to 10 seconds.

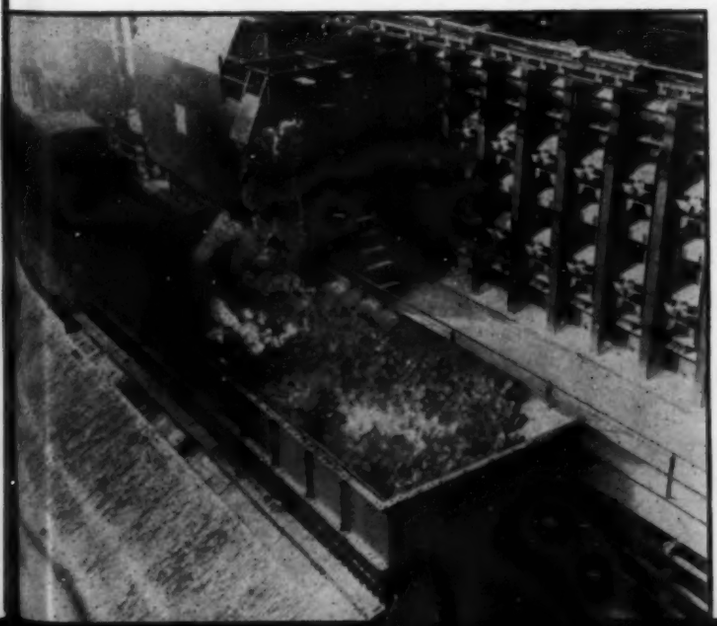
The coke quenching cars each have a rated capacity of 10 tons of coke, and have bodies 40 feet long, cast-steel side frame trucks, rolled steel wheels, self-aligning roller bearings at the journals, and two gates operated by a single motor through a speed reducer, shaft and operating arms attached to the doors (Figure 3). Motors, shaft and arm bearings are fitted with grease gun fittings; speed reducer bearings are lubricated by oil in the housing; journal bearings are arranged for oil lubrication.

The coal bin was designed to have a net operating capacity of 3500 net tons of coal weighing 48 pounds per cubic foot, and has a gross capacity of approximately 4000 tons of coal. The bin is built of reinforced concrete. Bottom hoppers are lined with hard-burned brick laid flat and curved at the valley angles. The bin is built in five bays with one row of hoppers.

Coke handling equipment consists of a 240-foot wharf, conveyors from the new wharf and two existing wharfs to a trunk line conveyor, coke scalping, crushing, screening and rail loading facilities, together with car haulage, sized coke surge bins, filling conveyors, motor operated bin gates for loading trucks, and motor operated bin gates for delivery of furnace and domestic coke to a proposed conveyor system to the blast furnace bins.

The plant is arranged to handle 8400 tons of coke per day. The 60-inch trunk conveyor has a capacity of 600 tons per hour and can handle the combined loading from the three wharfs at a rate of 200 tons per hour each. Coke from the wharfs is delivered to a common coke box from which the trunk line belt draws its load up to 600 tons per hour.

Figure 3 — Hot coke is shown here emerging from the coke guide. The coke quenching car into which the coke falls has a capacity of 10 tons.



At Low Cost

FUSETRONS PROTECT

Coils, Solenoids, Transformers

AGAINST BURNOUTS

"In this institution we have 5 dumb waiters or elevators used for delivering meals to the various floors. They are driven by 5 h.p. motors. Prior to 1938, 10 ampere one-time fuses were used in the control circuit to protect the coils and 30 ampere fuses were used in the motor circuit. The 10 ampere fuses were too large to protect the coils properly, and they burned out frequently. Fuses in the motor circuit blew so frequently that it was necessary for a man to stand by three times a day at mealtimes ready to replace fuses as they blew.

"In the fall of 1938, when I became Chief Engineer of this hospital, one of the first things I did was to check over all panels, switches and fuses. In these elevator circuits I installed 6¼ ampere Fusetrons to protect the coils in place of 10 ampere one-time fuses, and 20 ampere Fusetrons in the motor circuit in place of 30 ampere one-time fuses. In August of 1945, I was able to report that since this was done in 1938, not one coil has burned out and it was no longer necessary to have a man stand by at mealtimes to replace fuses in the elevator motor circuit. That trouble has disappeared entirely."

Leland J. Mamer, Chief Engineer
Evanston, Ill.

"The transformers on our meter testing boards require protection by one ampere fuses. These fuses, however, were blown whenever a motor was cut in on the ascending cycle of the current wave due to current surge.

"In October 1945 we installed one ampere Fustats (Fusetrons with a tamper-resisting base). They reduced needless blows from about five per week to one per month and at the same time completely eliminated any danger of damage to the transformers in the circuit."

A. L. Pollard
General Superintendent of Operations
Puget Sound Power & Light Co.
Seattle, Washington

What is the Fusetron?

The Fusetron is a Dual Element device — a Fuse to which is added a Thermal cutout.

The result is a fuse with tremendous time-lag and much less electrical resistance.

Fusetrons have the same degree of Underwriters' Laboratories approval for both motor-running and circuit protection as the most expensive devices made.

Made to the same dimension as ordinary fuses, Fusetrons fit all standard fuse holders.

Obtainable in all sizes from 1/10 to 600 ampere in both 250 and 600 volt types. Also in tamper-resisting type (Fustats) for 125 volt circuits.

Their cost is surprisingly low.

BUSS

Eliminate Shutdowns Simply and Inexpensively

Fusetrons Can Save Costly and Troublesome Replacement Jobs

Why risk the loss of expensive coils, solenoids and transformers when you can protect them with Fusetrons? At a cost of just a few cents, a Fusetron, properly installed, will protect against costly burnouts.

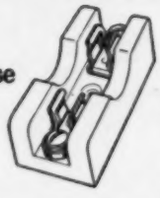
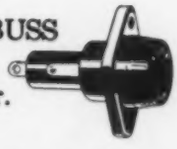
A transformer or coil can be protected because the long time-lag of the Fusetron permits it to hold all normal current surges and harmless overloads — yet it will open to prevent burnout on any dangerous overload.

A solenoid, likewise, can be protected because the Fusetron will not open on the operating surge but will open in time to protect should the heavy current continue too long for any reason.

Burnouts mean costly and troublesome repair or replacement jobs. Why take a chance on crippling your operations?

Here's All You Need

TO PROTECT COILS, SOLENOIDS, TRANSFORMERS.

A Fusetron of proper size, plus a fuse block—  or a BUSS fuse-holder. 

On voltages up to 125, the same accurate, dependable protection can be provided with

a proper size plug Fusetron or a Fustat, plus a fuse block.

Fusetrons Give Many Other Kinds of Protection Heretofore Not Available

Fusetrons do everthing fuses do, as is confirmed by Underwriters' Laboratories Label, and in addition . . .

- Entirely wipe out needless blows caused by motor starting currents or other harmless overloads.
- Give Thermal Protection to Panelboards and Switches.
- Lesser resistance means cooler operation and prevents needless blows caused by heating in panels and switches.
- Permit use of larger motor or adding more motors on circuit WITHOUT installing larger switch or panel.
- On new installations, PROPER size switches and panels can be used instead of OVERSIZE.
- Protect small motors against burnout, simply and inexpensively.
- Give DOUBLE protection to large motors.
- Provide simplest way to stop burnouts from single phasing.
- Protect coils, transformers and solenoids against burnout.

Get All the Facts

Get Better Protection — Send the Coupon Now

Don't risk avoidable losses. One burned out solenoid — or one needless shutdown — or one destroyed panel — may cost you more than replacing every fuse with a Fusetron.

You simply protect your pocketbook by installing Fusetrons throughout the entire electrical system.

Fusetrons

Sold Through Wholesalers

Bussmann Mfg. Co., University at Jefferson
St. Louis 7, Mo. (Division McGraw Electric Co.)

Please send me complete facts about BUSS Fusetrons.

*Name*_____

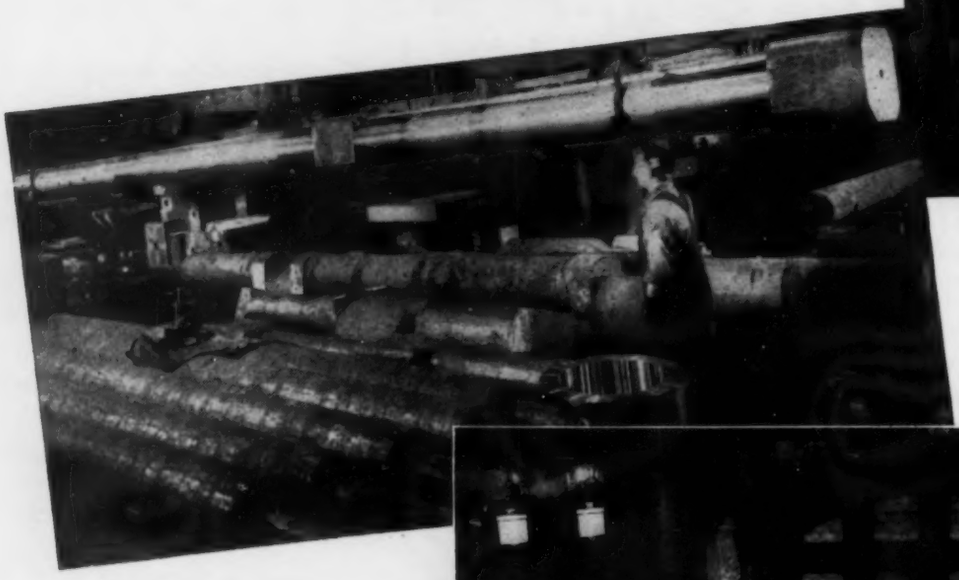
*Title*_____

*Company*_____

*Address*_____

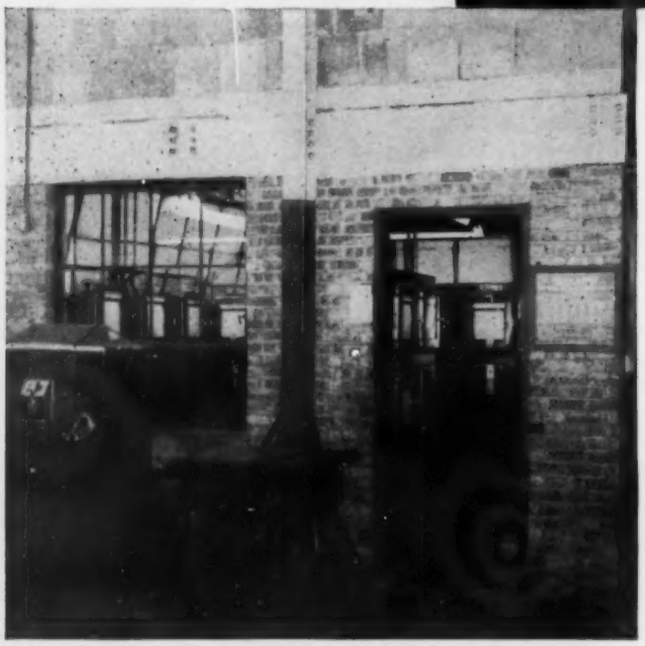
*City*_____ *State*_____ 348

Micromax Controls Temperature Of Heavy Forgings by Finkl



Above: Operator checks accurate, legible record of Micromax Controller against metallurgist's temperature instructions.
Left: Typical Finkl Forging. Used on earth moving machinery, this shaft is 40 ft long, 19 in. in diameter, and weighs 19½ tons.

Right: One of a semi-circular band of four furnaces at A. Finkl & Sons Co., Chicago. Micromax instruments control furnace temperatures by regulating fuel-feed, and record temperature conditions for forging die blocks and other products.



A few of the many Micromax Controllers which are located in the specially-built Control Room can be glimpsed through the open door and window.

A. Finkl & Sons Co. are specialists in precision forging; they make die blocks and inserts, piston rods and rams, sow blocks, crankshafts, etc. They set high standards for the control of temperature at all stages of manufacture. Micromax Controllers, arranged to operate the right combination of L&N widely-used control components, have long been employed throughout the Finkl plant. On small furnaces and large, Micromax Control Systems meet Finkl's exacting and unusual requirements.

Micromax equipment is a "natural" for forge shop operation, because the usually severe ambient conditions have no effect on sensitivity or dependability of Micromax operation. Finkl takes advantage of this toughness and flexibility to locate each Micromax for best usefulness. Some instruments are centralized so that one man can keep an eye on the operation of many furnaces. But when the continuous record is needed right at the furnace, that's where the Micromax is installed, to help the heat-treater to a quality job.

Our engineers are always ready to recommend the proper type of pyrometric equipment for any given service. Write to Leeds & Northrup Co., 4942 Stenton Avenue, Philadelphia 44, Pa.

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

LEEDS & NORTHRUP CO.

Ir. Ad N-33-683(1)

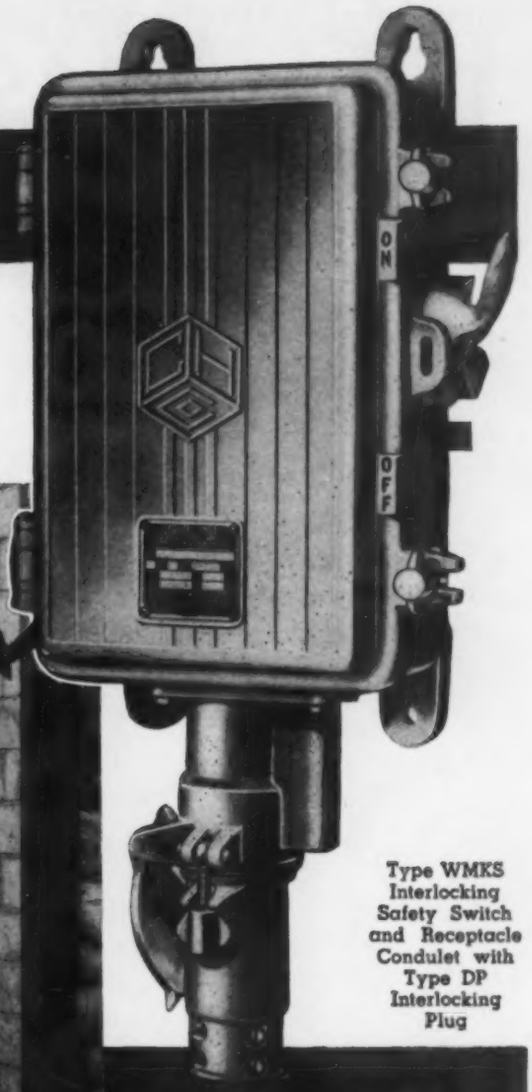
Type WMKS **Interlocking** Safety Switch and Plug Receptacle

CONDULET*

for the control of all kinds of

portable electrical equipment

in both indoor and outdoor locations



Type WMKS Interlocking Safety Switch and Receptacle Conduiet with Type DP Interlocking Plug

It's **heavy duty!**
It's **raintight!**

Safety. Positive interlock prevents opening the case or withdrawing the plug unless the switch is "off". Switch can't be turned "on" unless the case is closed and the plug fully inserted.

Switches. Motor circuit switch. Quick make and break. Double break, reinforced, positive pressure-type blade and jaw construction. Positive pressure fuse clips. Combination solder or solderless wire lugs. 2 or 3-pole fusible.

Plug Receptacles. Style 1 is grounded through the shell of the plug and the receptacle housing. It will take the plugs used with the former Type MKS of the same rating. Style 2 is grounded through an extra pole and the shell. An eyebolt and wingnut prevents accidental withdrawal of the plug when the switch is open.

Cast metal case. Strong and durable. Four sturdy mounting feet. Many possible threaded hub arrangements for both vertical and horizontal conduit. Cover may be padlocked to prevent unauthorized entry. Operating handle may be padlocked "on" or "off".

Threaded operating shaft. Bearings permanently lubricated to resist corrosion and prevent the entrance of dust and moisture.

Horse-power ratings. 2 through 50 H. P. 30, 60, 100 or 200-ampere. 230 or 575-volt A. C.

Listed in Conduiet Catalog 2500, Section 50.

*CONDULET is a coined word registered in the U. S. Patent Office. It designates a product made only by the Crouse-Hinds Company.

A Nationwide Distribution Through Electrical Wholesalers

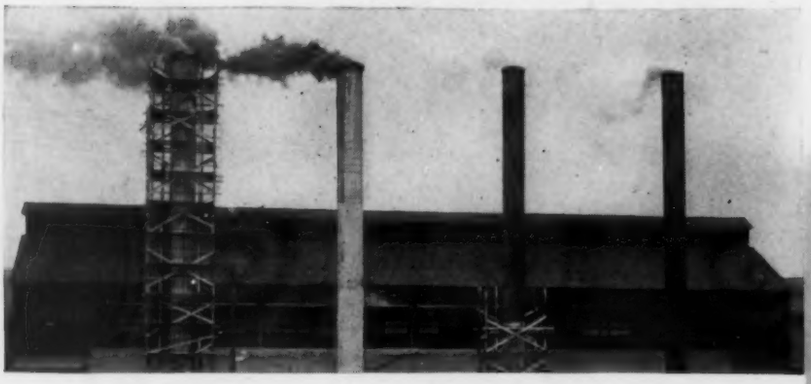
CONDULETS
FLOODLIGHTS
TRAFFIC SIGNALS
AIRPORT LIGHTING

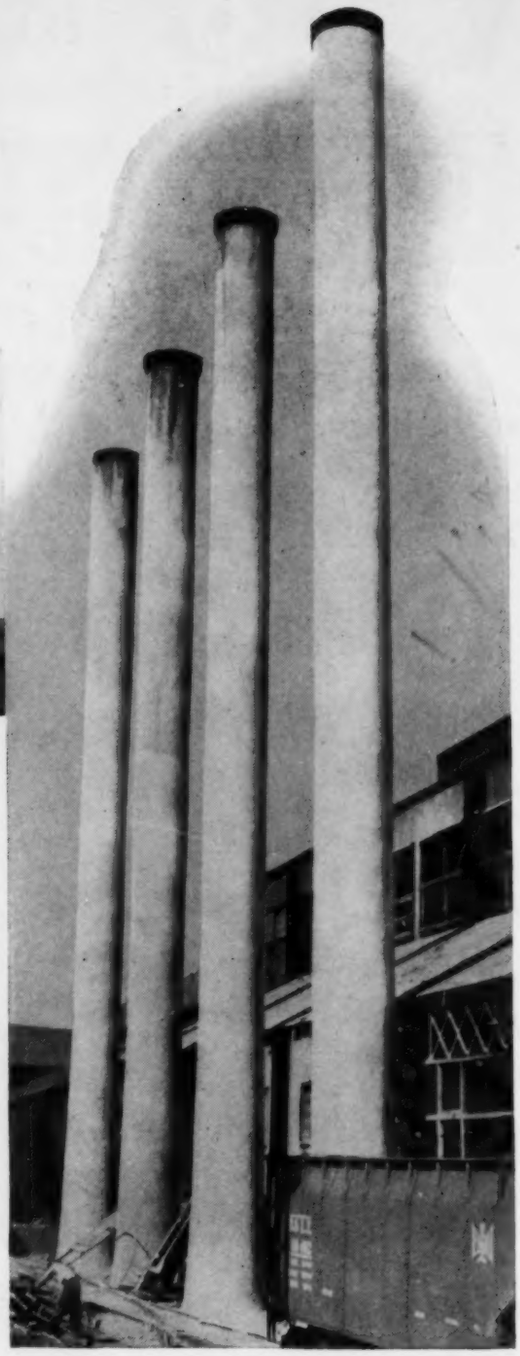
CROUSE-HINDS COMPANY
Syracuse 1, N. Y.

Offices: Birmingham – Boston – Buffalo – Chicago – Cincinnati – Cleveland – Dallas – Denver – Detroit – Houston – Indianapolis Kansas City – Los Angeles – Milwaukee – Minneapolis – New York – Philadelphia – Pittsburgh – Portland, Ore. – San Francisco Seattle – St. Louis – Washington. *Resident Representatives:* Albany – Atlanta – Charlotte – New Orleans – Richmond, Va. CROUSE-HINDS COMPANY OF CANADA, LTD., *Main Office and Plant:* TORONTO, ONT.

NEW STACKS for OLD

WITHOUT SERVICE INTERRUPTION





New, Insulated, Corrosion-Protected, Self-Supporting Chimneys Built While Furnaces Are on Heat

HERE'S a quick, economical way to rebuild industrial stacks—while the stacks are working. Eliminates shut-down time. Saves expense of dismantling the old stacks.

While these soaking-pit stacks were in full operation, asbestos sheeting was wrapped around the steel shell and a reinforcing system was erected. Next, a coating of LUMNITE insulating mortar was shot on to form the lining of the new stack. The structure was completed by shooting in place concrete made with Universal portland cement and sand.

Scores of rebuilt stacks have proved the effectiveness and economy of this special, patented method. A new reinforced concrete stack is built up around the old steel shell. The refractory, corrosion-resistant, LUMNITE lining assures long service life.

Four soaking-pit stacks at Ohio Works, Carnegie-Illinois Steel Corporation, Youngstown, Ohio. Rebuilt with LUMNITE-lined Gunite concrete by Cement Gun Co., Allentown, Pennsylvania.

Lumnite Division

UNIVERSAL ATLAS CEMENT COMPANY

UNITED STATES STEEL CORPORATION SUBSIDIARY

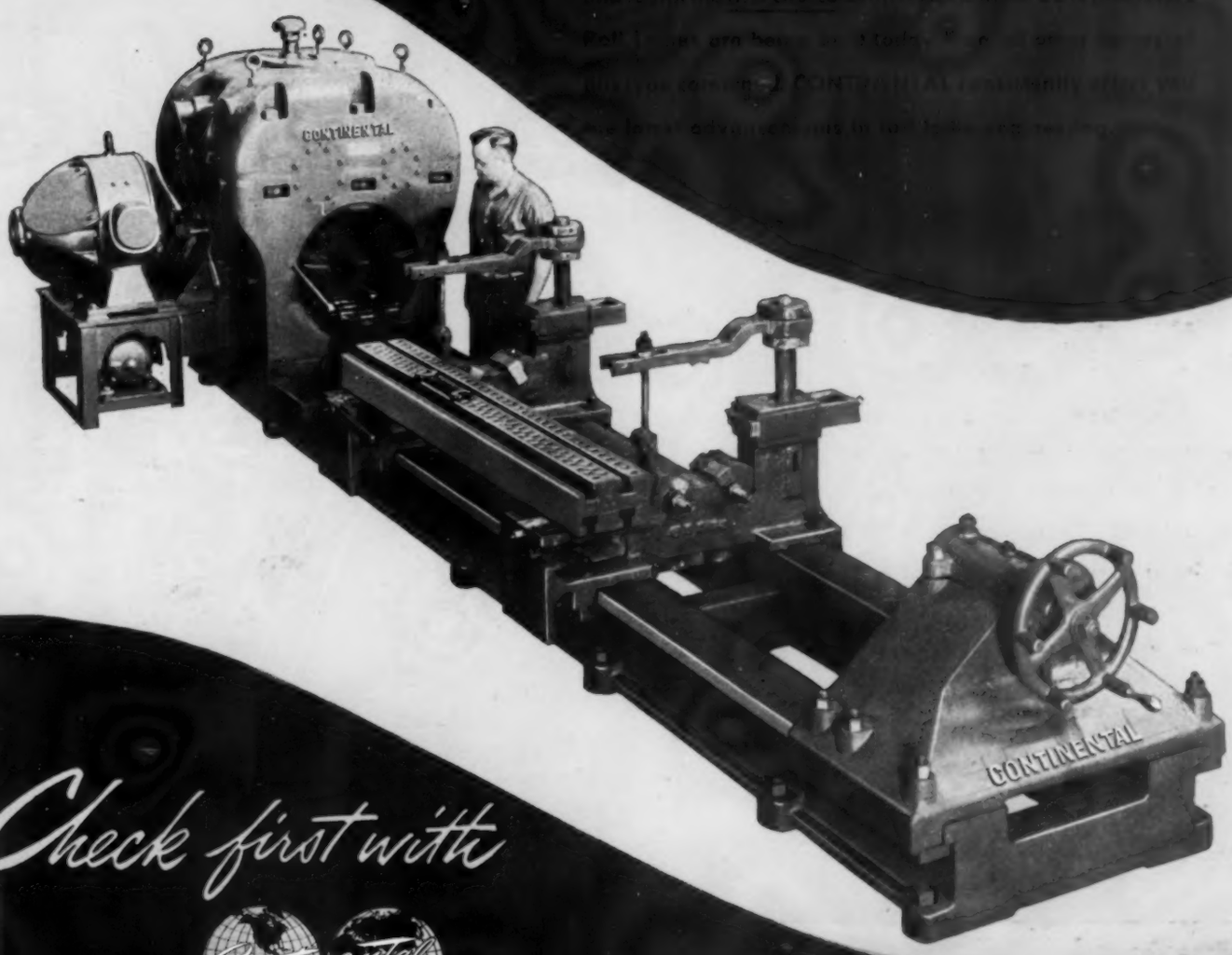
135 EAST 42nd STREET • NEW YORK 17, N. Y.

"THE THEATRE GUILD ON THE AIR"—*Sponsored by U.S. Steel—Sunday Evenings—ABC Network*

Continental

Industry's Major Source for

ROLL LATHES



Check first with

Continental

FOUNDRY & MACHINE CO.

CHICAGO · PITTSBURGH

Plants at:

East Chicago, Ind. · Wheeling, W. Va. · Pittsburgh, Pa.

24" I BEAM STRAIGHTENER

BUILT BY MORGAN Engineering

Illustrated is a Morgan Roller Straightener for structural shapes up to 24" I beams.

It is equipped with four top and four bottom rolls, all of which are adjustable. These eight rolls are arranged to be connected by spindles to a separate enclosed gear box drive. All gear shafts are mounted in roller bearings. Vertical rolls are provided on both entry and delivery sides.

A section of roller table is mounted on one side of straightener to be shifted into the roller table line when straightener is not in use.

DESIGNERS • MANUFACTURERS • CONTRACTORS

BLOOMING MILLS • PLATE MILLS • STRUCTURAL MILLS • ELECTRIC TRAVELING CRANES • CHARGING MACHINES • INGOT STRIPPING MACHINES • SOAKING PIT CRANES • ELECTRIC WELDED FABRICATION • LADLE CRANES • STEAM HAMMERS • STEAM HYDRAULIC FORGING PRESSES • SPECIAL MACHINERY FOR STEEL MILLS

THE MORGAN ENGINEERING CO.
ALLIANCE, OHIO
Pittsburgh 1420 Oliver Building

NEWS SUPPLEMENT APRIL, 1948

Equipment
Personnel
Literature

Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

HIGH TOP PRESSURE BLAST FURNACE BLOWING TECHNIQUE TO BE EXTENDED AT REPUBLIC

▲ Republic Steel Corporation will extend the use of its recently developed high top pressure blast furnace blowing technique to five additional furnaces during the present year. This revolutionary practice has proven to be of great significance in increasing pig iron production.

By this practice greater than normal volumes of air are blown into the bottom of a blast furnace while a throttle valve at the top restricts escape of the waste gases, thus building up gas pressure within the furnace, and reducing the velocity at which the gas passes through the furnace. As a result, the coke burns more efficiently, a greater quantity of pig iron can be produced per day, cost of pig iron production is less, and ores of fine particle size can be economically used.

When the high pressure installations are completed on the additional five furnaces, the increased pig iron capacity which will result will be nearly the same as if an additional furnace had been built.

Installations will be made at furnaces at Warren, Buffalo, South Chicago and at two additional Youngstown furnaces. New blowing equipment will be installed at Buffalo and Warren, but the other furnaces will use their present blowing machinery.

Increases in pig iron production by high top pressure operation is one way the company hopes to make up for the current shortage and high price of scrap. In addition the decrease in the amount of coke consumed for each ton of iron produced will assist in eliminating the need for some coke, also a scarce and expensive item. The program will enable Republic to further its steelmaking operations rather than to increase merchant iron supplies.

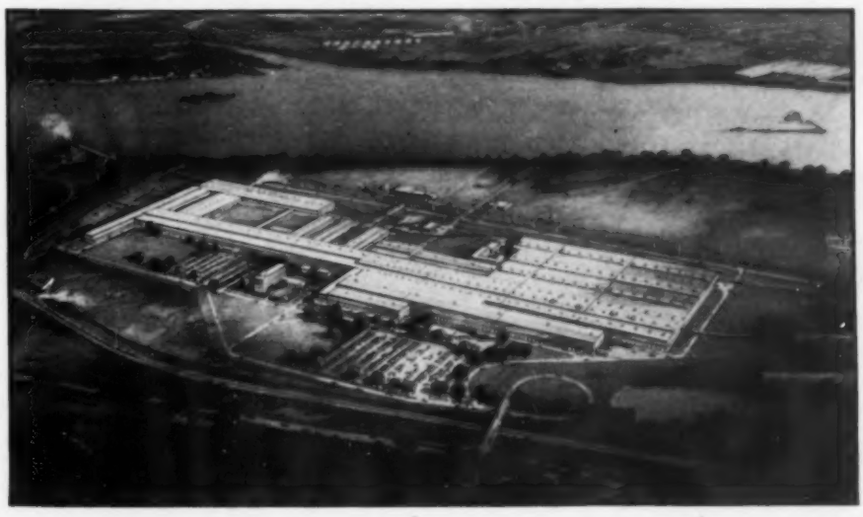
The most important installation will be at the Warren furnace where a huge new turboblower is to be installed. This blower, now under construction by the Ingersoll Rand Company, will be able to provide 125,000 cfm of air at 40 lb pressure. It will be the largest air moving and compressing machine in use in the steel industry. With this blower and adaptation of the furnace to high top pressure operation, production is expected to top 1600 tons of iron per day. This is more than twice the rated capacity of the average American blast furnace and 25 per cent above the rated capacity of this furnace.

A Republic furnace in Cleveland has been on high top pressure operations since July 1, 1946. A burden of ore leaner than the average has been used and during most of this period no scrap or sinter has been added. The production has soared as high as an average of 1484 tons per day over a single month. Meanwhile, coke consumption per ton of iron produced has been reduced 200-250 lbs. This furnace has been blown with air volumes as high as 110,000 cfm at 31 lbs pressure. In ordinary practice air volumes of 85,000 cfm are extremely rare. The pig iron production of a blast furnace

ALUMINUM ROLLING MILL NEARS COMPLETION

The greatest single application of aluminum ever achieved in the building trades was unveiled with the disclosure that the Aluminum Company of America, is using more than six and a quarter million pounds of aluminum in the construction of its nearly-completed Davenport sheet and plate rolling mill.

The giant plant, extending for nearly a mile along the banks of the Mississippi river, is basically an all-aluminum project, with the exception of 25,000 tons of structural steel framework which is painted with more than three carloads of aluminum paint.



is in direct proportion to the amount of air blown into the furance.

The new Buffalo turboblower will be a five stage compressor, able to provide 95,000 cfm at 40 lb pressure. The installation will be very similar to that of the Youngstown No. 3 furnace where exceptionally good results have been obtained.

Conversion of two additional furnaces at Youngstown will ultimately result in pig iron increases which will enhance the importance of Republic's sprawling steel works in that city as a supplier of slabs, billets and bars to Republic's finishing mills in Youngstown and elsewhere.

The Chicago furnace when completely installed for high pressure operation will be almost identical with the Cleveland unit and correspondingly increased tonnages are expected. Republic's Chicago plant is an important supplier of alloy and carbon bars and billets to the trade and produces large tonnages of wire and wire products including nails.

The importance of the Warren plant as a producer of hot and cold rolled sheet and strip steel and tin and zinc plate will be enhanced by the greater supply of pig iron available.

Under high top pressure methods, the velocity of air within the furnace is so slowed down that use of fine ore is practicable without sintering it into a lump or cinder; consequently, high top pressure blast furnaces loom as significant in the future use of the low grade Lake Superior iron ores which must be ground fine and concentrated before use.

SALES REPRESENTATIVES INSPECT PLANT

An initial postwar sales conference was held recently by the Electric Service Manufacturing Company in Philadelphia. Headquarters were in the Warwick Hotel, where most of the meetings were held. However, trips were taken through the illumination laboratories and the high voltage laboratories at Plant "A." Inspection was also made of the new and enlarged facilities for producing fluorescent light fixtures in Plant "B."

PACKAGE STEEL BALLS IN INDIVIDUAL CONTAINERS

▲ Precision steel balls manufactured by the Atlas ball division of SKF Industries, Inc., are being made available in less than bulk lots in a new packaging program placed in effect recently by the Philadelphia ball and roller bearing company.

Under the new program, 22 sizes of balls are packaged in individual containers for resale by distributors and automotive jobbers throughout the country. Package quantities range from 350 balls of the smallest size, $\frac{3}{32}$ in., to 25 half-inch and four one-inch balls, largest put up in this manner.

The unit packaging program, according to SKF, is designed to eliminate loss from corrosion since the balls are untouched from the time they leave the factory until application.

SOUTH AFRICAN STEEL BUYS CRANE CAB COOLERS

▲ Dravo Corporation has received an order for the South African Steel Company, Johannesburg, for six crane cab coolers. The units will be installed on three soaking pit and three ladle cranes in the steel mill that is under construction for that company in South Africa.

These crane cab coolers provide conditioned air for the cabs of cranes operating in high temperatures, heavy dust or noxious fumes. The unit cools or heats the air, as required, and filters it to remove fumes and dust.

REFRACTORY CONCRETE CAN SUPPORT LOADS

▲ A high-strength, chrome-base refractory concrete, known as "Kromecast," which is able to withstand temperatures as high as 3100 degrees F, has been developed by Babcock and Wilcox Company, officials of its refractories division announced. The new product is of major importance for industrial furnaces because it makes available for the first time an easily installed concrete combining the refractory and slag-resisting properties of chrome-base materials with the ability to support loads at high temperatures.

This new concrete, which can be poured into place as easily as ordinary concrete or applied by plastering or with a cement gun, possesses exceptional volume stability at temperatures up to 3100 F, while providing protection against attack by fuel slags, metallurgical and chemical slags, molten materials and other reactive products. The new product makes the desirable qualities of a chrome-base refractory available for many applications in which such a material cannot now be used.

While the refractory and slag-resisting properties of chrome ore have long been recognized, its installation in plastic form by ramming and pounding required considerable time and labor. Also previously available chrome plastics as well as concrete had a tendency to slump if used in vertical walls without extensive support. It is pointed out that the new concrete, however, can be installed in a fraction of the time required for plastics and, because of its strength at elevated temperatures, can be used to construct vertical walls and roof arches in many types of furnaces that formerly had to be made of less resistant materials.

Applications listed by Babcock and Wilcox Company where the concrete will cut down construction time, reduce furnace maintenance, and contribute to longer sustained operating periods, include: furnace walls; hearths and floors in metal heating and forg-

ing furnaces; car tops; electric furnace roofs; water-cooled boiler furnaces operating at high temperatures; furnace door and frame linings; patching furnaces which have been damaged; forming special shapes quickly and inexpensively.

For use in furnaces where temperature and spalling conditions are not as severe as those requiring the use of this new concrete, Babcock and Wilcox Company announced a second new product, "Hydrochrome." This chrome-base concrete has a temperature use limit of 2800 F and is recommended for the great majority of water-cooled boiler furnaces and for metal processing furnaces with moderate operating temperatures.

DEVELOP MULTI-SHELF RACK FOR BATCH TRANSPORT

▲ The Chemung Foundry Company of Elmira, New York, solved the problem of transporting large batches of small, odd-shaped, green-cores, by the use of a six-foot, multi-shelf, angle-iron rack. The rack is used to haul quantities of cores from the coremaker to the bake ovens. Its construction shows considerable skill-in-design for the job it is to do.

The shelf-ledges comprise 2× 2 in. angles welded flange to flange so as to form channel-like members. The welded-angle construction is used instead of ready-made channels in order to facilitate machining operations which are done before assembling. Holes are drilled in the flange of one angle so that it can be bolted to the rack frame. Notches are cut in the flange of the second angle to secure pipes which make up the shelves.

The pipe construction permits the steel plates on which the cores are placed to be easily loaded onto the rack. The pipes can rotate slightly when the plates are loaded on or off, but they will not rotate during transit

The rack is transported by a spring-frame hand truck.

Ohio Electric announces a welded lifting magnet with *PROTECTO-WELD* design

The easiest way to protect the weld on a welded lifting magnet is obvious: PUT IT ON TOP.

That's the big advantage of new Ohio PROTECTO-WELD magnets. Outer ring and top plate are welded together *on top of the magnet.* Frequent blows against the outer ring *cannot crack or damage the weld.* Ohio PROTECTO-WELD magnets remain hermetically sealed against moisture indefinitely!

Three sizes of this new magnet are now in production. They measure 39, 55 and 65 inches in diameter. Name the lifting job—we can give you all the strength you need. Besides the 4-coil construction, there are also 6 or 8-coil magnets for that *extra Ohio lifting strength.*

These PROTECTO-WELD magnets have the well known Ohio chain pins that fit into square-holed ears—to eliminate friction and prolong life. Ohio Armored Weatherproof cable connectors withstand severe abuse. Bayonet joints for hand operation save time in making and breaking connections. Shielded contacts provide safety from arcs.

This new Ohio PROTECTO-WELD magnet is a rugged tool for your roughest jobs. *Details?* Write today to Ohio: *leader in magnetic materials handling.*

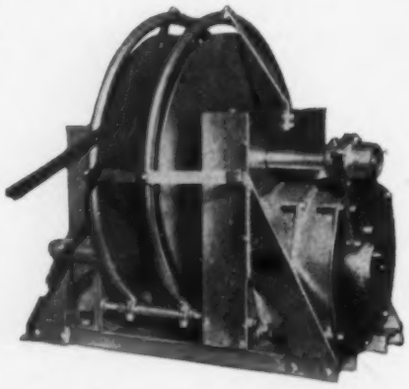
Ohio MAGNETS

also a leading name in the small motor field

THE OHIO ELECTRIC MFG. CO.

5907 MAURICE AVE. • CLEVELAND 4, OHIO

A NEW LINE OF
EXTRA HEAVY DUTY
GLEASON CABLE REELS



SM SERIES

Spring Driven Geared Reel
For Electric Cables
125 Amps — 600 Volts
Continuous Contact
All Ball Bearings
Two-way Payout
Non-Revolving Springs
Fabricated Steel
Watertight
Replaceable Spring Motors
Adjustable Tension
8 Standard Sizes

These reels were developed to meet the unusually severe operating conditions found throughout the steel industry and are of exceedingly rugged construction.

The spring motors are interchangeable and removable so they may be replaced without handling loose springs. Replacement springs are supplied by the factory already installed in the housings and the replaced housings are returnable for credit.

The springs are wound on extra large hubs to minimize flexing at that point.

Adjustment of the spring torque is accomplished by means of a crank handle which is removable. A lock is provided to hold the drum in position during spring adjustment.

Improved current collector and brush rigging, with extra wide spacing, minimizes the possibility of electrical troubles.

J. L. GLEASON & CO., Inc., 209 Bent St., Cambridge, Mass.

You Can Make
3,000* Calls a Day

—BY EXHIBITING YOUR EQUIPMENT
—BY SEEING YOUR CUSTOMERS—PROSPECTS

at the 1948
IRON AND STEEL EXPOSITION

CLEVELAND AUDITORIUM · CLEVELAND, OHIO

September 28, 29, 30, October 1

*Total attendance for four days of the Exposition will be 12,000 or more key executive and purchasing officials of the Steel Industry—your customers and prospects. You can see and sell 3,000 each day!

For Complete Data Write

Association of Iron & Steel Engineers
1010 EMPIRE BUILDING · PITTSBURGH, PA.

due to the downward weight of the loaded steel plates.

The shelves can be raised or lowered to accommodate various sized cores by bolting the channel-ledges to suitable bolt-holes located in the rack-frame. Notice the difference in shelf-heights on the two racks illustrated. Notice also the difference in core-sizes.

The rack is transported by a special spring-frame Yale and Towne hand truck which makes it possible to transport safely the large number of fragile cores; danger of damage due to shocks being transmitted from typically uneven foundry floors is avoided. Larger cores can be placed directly on the truck platform.

SLAB FURNACES TO BE BUILT AT J & L OTIS WORKS

▲ Three slab heating furnaces, each of 100-ton per hour capacity, will be built for Jones and Laughlin Steel Corporation at Otis works, Cleveland, Ohio. Rust Furnace Company is designing and will build the triple-fired, zone controlled slab heaters for a hot strip mill. The furnaces will be equipped for either gas or oil firing.

INSTRUMENTS EMPLOY JEWELED BEARINGS

▲ A new line of long-scale switchboard instruments employing bearings with spring-mounted jewels which work to protect the pivots even under conditions of abnormal shock or abuse has been announced by General Electric's meter and instrument divisions.

The new Type AB-15 (a-c) and DB-15 (d-c) instruments are designed for general switchboard use by electric utilities and large industries.

The new instruments have scales 7.1 in. long spanning 250 degrees about the center. To facilitate correlation of the numerals with the proper scale divisions, numbered major divisions are accented. All legends, such as "a-c Amperes" etc., are located below the center of the scale and thus are never partially covered by the pointer. All scale numerals are horizontally placed to facilitate readings.

The new bearing construction permits hard use without harm to the

MORGAN WORCESTER ROLLING MILLS

195

on the job* . . more on the way

A high percentage of the world's output of billets, rods, merchant shapes, strip and skelp is rolled on Morgan mills.

Morgan achieved preeminence in the field by introducing the first successful continuous rolling mill and has retained leadership through a steady stream of technical advancements.

No two Morgan Mills are exactly the same. Each was engineered to meet specific needs. Each fulfilled its purpose a little better than its predecessor.

With 195 mills and 55 years behind us we are ready to apply what we have learned to *your* problem. Why not write us today to talk it over? RM-16

MORGAN CONSTRUCTION CO.
WORCESTER, MASSACHUSETTS

English Representative: International Construction Company
56 Kingsway, W. C. 2, England

*This includes 15 mills of types not illustrated.

pivots. If, due to shock, the pressure of the pivot on the jewel is appreciably higher than normal, the jewel merely recedes into the screw. Before the jewel hits bottom, the shoulder on the end of the shaft strikes the top of the jewel screw and takes the shock, thus protecting the jewel and pivot.

The instruments can be easily disassembled for inspection or repair. Moving elements can be withdrawn from the mechanism without disturbing the control springs or the jeweling. This means that the assemblies can be removed and replaced without noticeable change in the scale distribution, resulting in reduced maintenance costs and often eliminating the need for recalibration and repair.

The mounting dimensions and general case size has not been changed. Types AB-15 and DB-15 are mechanically interchangeable with older Types AB-13 and DB-13.

The new long-scale line, designed to meet the basic requirements of Navy specifications, retains many features found in present G-E switchboard instruments: one per cent of full-scale accuracy, anti-parallax scale, non-glare glass, thorough shielding from stray fields, external zero adjusters (when required), high overload characteristics, and good performance under conditions of varying ambient temperature.

HAYS Indicating and Recording Instruments and Automatic Controls are delivering vital improvements in the making of steel—

LABOR SAVING is effected, for by doing the job automatically, manual attention is reduced to supervision only and the job is actually done better than can be performed manually.

MATERIAL SAVING is effected, for by controlling to the most desirable set requirements, excess quantities are eliminated, resulting in saving of power, heat, steam, water, gas, air and other critical materials.

PRODUCT IMPROVEMENT is effected by reducing variables in quantities, pressure, flow, etc., of the controlled material. The correct condition or quantity is assured at all times and uniformity and quality of product is increased as well as the output. Also rejects and spoilage are reduced, sometimes entirely eliminated.

This important Bulletin 46-713—new, informative, exceedingly helpful—tells the story; complete with schematic drawings of typical applications. Write for your copy.

The HAYS CORPORATION
COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA, U.S.A.

BUREAU OF MINES PUBLISHES REPORT

▲ Concluding all war research on coal, the Bureau of Mines during the fiscal year 1947 emphasized improvements in mining, preparation, and utilization of coal and centered special attention on conservation, safety research, coking coal, and synthetic liquid fuels, according to a report released by James Boyd, Director of the Bureau.

Outstanding achievements of the Bureau are recorded in the report, which is the 12th annual review of research and technologic work on coal. The Bureau's broad field of research included coal mining and exploration, coal sampling and analysis, gas-and-dust explosion research, coal preparation and storage, and coking and gasification studies.

To offset the depletion of high-grade coking-coal reserves, the bureau last year intensified studies of less desirable coals and demonstrated that high-sulfur or high-ash coals could be upgraded to make them suitable for metallurgical use. It was determined that with suitable preparation methods, about 500,000,000 tons of Maryland coal and a 14,000,000-ton reserve in thin beds of Alabama could be used for making metallurgical coke. An investigation of bituminous coal reserves in the Matanuska field of Alaska was started, and as a further aid to the western steel industry, a survey of the amount and coking quality of coal in Gunnison County, Colorado, was continued.

Concern over the diminishing petroleum reserves and the lack of outstanding new discoveries focused increased attention on the bureau's synthetic liquid fuels program last year.

Nation-wide interest was aroused in the first American attempt at underground gasification of coal which offers the possibilities of efficiently using some of our coal resources with-

out extensive underground work and of utilizing beds that cannot be mined economically. The exploratory test conducted jointly by the bureau and the Alabama Power Company at Gorgas, Alabama, a year ago indicated the practicability of underground gasification and the bureau recommended further research.

Single copies of the Bureau publication Information Circular 7446, "Annual Report of Research and Technologic Work on Coal, Fiscal Year 1947," by A. C. Fieldner, Chief of the Fuels and Explosives Division, and Paul M. Ambrose, former assistant chief, Fuels and Explosives Division, may be obtained free by writing to the Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburgh 13, Pennsylvania.

BLOOM ENGINEERING IS NOW INCORPORATED

▲ Bloom Engineering Company, specialists in industrial and steel mill furnace burners and their application, announced its incorporation as of February 24, with F. S. Bloom as president and treasurer, and L. F. Conway, as vice president and secretary.

Responsible for many important developments in industrial combustion practice and fuel equipment, the company's burners have been used principally for soaking pits, open hearth, billet heating, forging and heat-treating furnaces.

DESIGN NEW RELAY FOR 600-VOLT OPERATION

▲ A new heavy duty, rear connected, multiple d-c magnet operated relay is announced by Westinghouse Electric Corporation. Designated the AYB, the new relay is available in 4, 6, 8, 10, 12 or 14 pole combinations.

The relay is designed for operation on 600 volts and below. All contacts are double break silver to silver; will carry 10 amperes continuously at rated voltage and have a maximum interrupting capacity of 150 volt-amperes (inductive coil load 0.65 amps at 230 volts). Its salient feature is a fast drop-out of the contacts when the coil is de-energized.

The new relay may be had with contacts that operate all normally open or in combination with some contacts normally open and some normally closed. To prevent overloading the operating magnet, not more than five normally closed contacts should be used in the combination.

The relay is a self-contained unit with all the parts mounted on a ½-in. thick Micarta back plate. The unit can be mounted easily on a control panel 2 in. thick or less. A mechanical interlock assembly is available for interlocking two relays side-by-side and on the same horizontal centerline. Stationary contacts can be removed from the front of the relay.

The relay is ideal for use on machine tools, in steel mills and for other heavy duty applications requiring interlocking of circuits.

IMPROVE PRINT WHEEL FOR MULTIPLE RECORDING

▲ An improved skip-numeral print wheel which when used with strip chart electronic recorders permits

A "TOUGH CUSTOMER"

For Open Hearth Service Blaw-Knox Buckets give you . . . Rugged strength for hard use . . . Speedy operation for quick clean-up . . . Safety features that prevent accidents . . . Types and sizes to meet your particular needs . . . From Catalog No. 2002 you will be able to select the bucket that exactly meets requirements. Write for it today.

BLAW-KNOX DIVISION
of Blaw-Knox Company
2040 Farmers Bank Bldg.
Pittsburgh 22, Pa.

BLAW-KNOX BUCKETS

symmetrical and well-defined multiple measurement records has been developed by the Brown Instrument division of Minneapolis-Honeywell Regulator Company.

"Field experience tests over the past several months," said L. M. Morley, vice president of the Honeywell company and its Brown division, "shows that the new skip-numeral print wheel overcomes a crossing of records and superposition of numerals of any one record. The new skip-numeral wheel utilizes the same basic system of plus and numerical identification. It also staggers the numeral locations for different records permitting use of slower chart speeds."

The use of slower chart speeds, it was added, permits a substantial chart economy while maintaining greater clarity and permanency of recorded measurements, particularly when used in conjunction with standard charts made for the electronic recorders.

SUBMERGED-MELT WELDER FOLLOWS ANY OUTLINE

▲ A new machine for making welds to any outline by its submerged-melt welding process has been announced by Linde Air Products Company. The WM-6 machine, a carriage of the type that has proved most useful in oxy-acetylene shape cutting, is used to carry and guide a Unionmelt welding head. Any desired outline can be followed by use of a strip templet.

Welding domestic fuel-oil tanks with the WM-6 shape-welding machine.

The Type U welding head has a maximum current capacity of 2000 amperes and can weld in a single pass material from 18-gage to 1¼-in. plate. Heavier parts of almost any thickness can be welded by a suitable number of passes.

The machine will operate over an area 34 in. wide and 80 in. long. Sections can be added to the tracing table so that any length can be covered. The welding speed is adjusted by a stepless speed control on the tracing machine. Standard or high speed tracing heads make it possible to weld at speeds from 4 to 40, or 11 to 100 in. per minute.

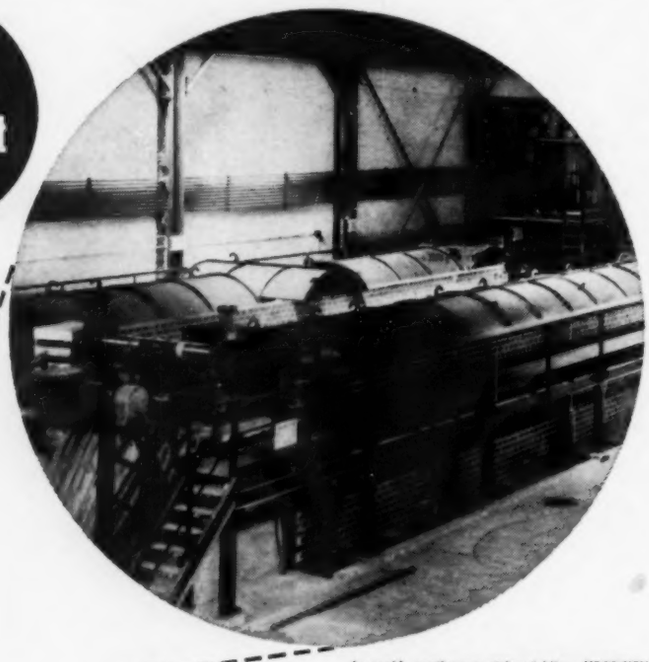
The machine has already been used in several plants for welding special shapes. An example of this type of work is the welding of ends to shells of domestic fuel oil tanks. This machine will be particularly useful in fully mechanizing the welding of certain intricately shaped parts that heretofore could only be welded manually.

TEMPERATURE INDICATOR MEASURES TO 5000 F

▲ The Fairchild Camera & Instrument Corporation has announced its unit laboratory gas temperature indicator is now available for measuring gas temperatures to 5000 F. The instrument is simple in operation and ruggedly constructed for laboratory use. The insertion of a probe into the gas stream and operation of a single control valve on the instrument case is all that is required to obtain gas temperature measurements.

Accuracies of 1 per cent are guaranteed up to 2000 F. In the 2000-5000 F

In the Spotlight



In rapid, continuous strip pickling, "RODINE" not only saves acid and metal but also prevents over-pickling during line shutdowns.
Photograph courtesy Mesta Machine Co., Pittsburgh, Pa.

*Rodine** IS A STELLAR PERFORMER IN PICKLING PLANTS THE WORLD AROUND

ACP
RUST PROOFING AND PAINT BONDING
Granodine ®
Parkrine ®
Rhodine ®
Lithodine ®
Thermit-Granodine ®
RUST REMOVING AND PREVENTING
Passivine ®
Perolene ®
PICKLING ACID INHIBITORS
Rodine ®

"RODINE"—the pioneer acid inhibitor—cuts production costs by reducing pickling costs.
"RODINE" in the pickling bath . . .
★ SAVES BOTH ACID AND METAL
★ PREVENTS OVER-PICKLING
★ INCREASES TONNAGE
★ GIVES BRIGHTER, MORE UNIFORM SURFACES
★ MINIMIZES ACID FUMES
Remember, it costs less to pickle with "RODINE" than without it.

Pioneering Research and Development Since 1914
AMERICAN CHEMICAL PAINT COMPANY
AMBLER, PENNA.
Manufacturers of Metallurgical, Agricultural and Pharmaceutical Chemicals

range, reproducibility of plus or minus 2 per cent is guaranteed.

The basic pneumatic gas temperature system is the heart of this new instrument. This system is a form of gas thermometer and utilizes the density of the gas being measured as a direct indication of temperature.

Temperature probes of suitable metals are furnished for temperatures to 2300 F, and water-cooled probes with iridium orifices are furnished for temperatures to 5000 F. Probe diameter, length and shape are tailored to customer specifications.

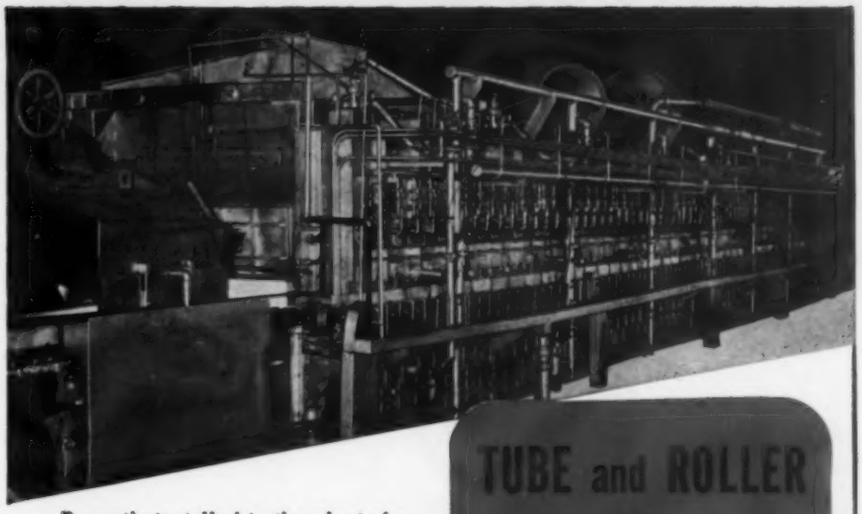
The indicator is especially suited for use with gas turbines, turbo jets, ram jets, rockets and general industrial laboratory use. Unit 263 is also valuable for determining the applicability of the Fairchild temperature system as a temperature responsive control or temperature limiting device for incorporation in any specific control system.

DEVELOP CLAMP-ON LINING FOR MAGNETIC BRAKES

▲ Cutler-Hammer, Inc. announces the development of a new brake shoe with "clamp-on" type lining for their line of Type M magnetic brakes for mill and heavy duty service. An ingenious, vise type clamp on the brake shoe holds the brake lining securely in place and prevents it from shifting in any direction. The clamp consists of a permanent buttress at the lower edge of the shoe with a simple, self-aligning screw jack at the top edge. The brake lining, of folded and compressed metallic asbestos, is placed in the shoe and the clamp tightened. This exerts a force on the end of the brake lining, forcing it into the curvature of the shoe and holding it firmly in place.

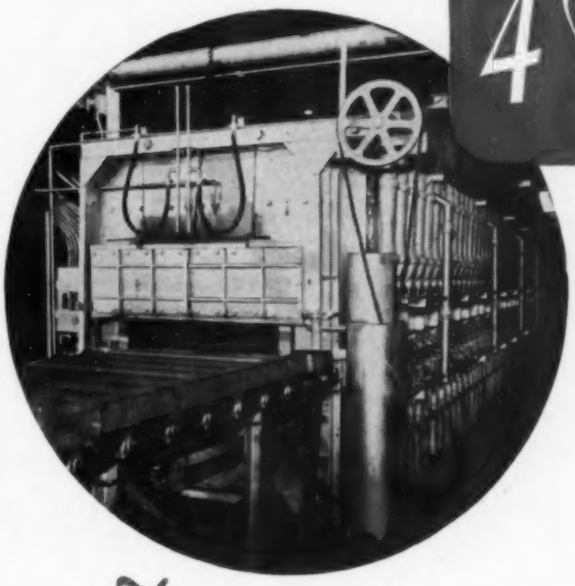
The advantages of this construction are (1) that it provides a brake lining surface that is completely smooth without rivet holes or high spots; (2) provides a larger braking area; (3) allows renewal of brake linings without removing shoes from brake and in less time than would be required to change the shoes; (4) eliminates the need for carrying spare brake shoes with linings and (5) gives longer, more satisfactory wear of both brake linings and wheels. The manufacturer states that in preliminary

(*Please turn to page 134*)



Recently installed in the plant of a large steel producer, this 5'6"x70' annealing furnace is used to anneal stainless steel sheets. It is equipped with *CARBOFRAX radiant tubes and rollers. (*CARBOFRAX is a registered trade-mark indicating manufacture by the Carborundum Company.)

TUBE and ROLLER HEARTH FURNACE UPS PRODUCTION 4 Ways



The improved design of this new GASMACO furnace has resulted in these production economies to the user: (1) manpower requirements reduced by 60% (2) stainless steel sheets are uniformly annealed within 2 points of hardness—surface finish is free of defects (3) pickeling time reduced to 20% (4) polishing time reduced 50%.

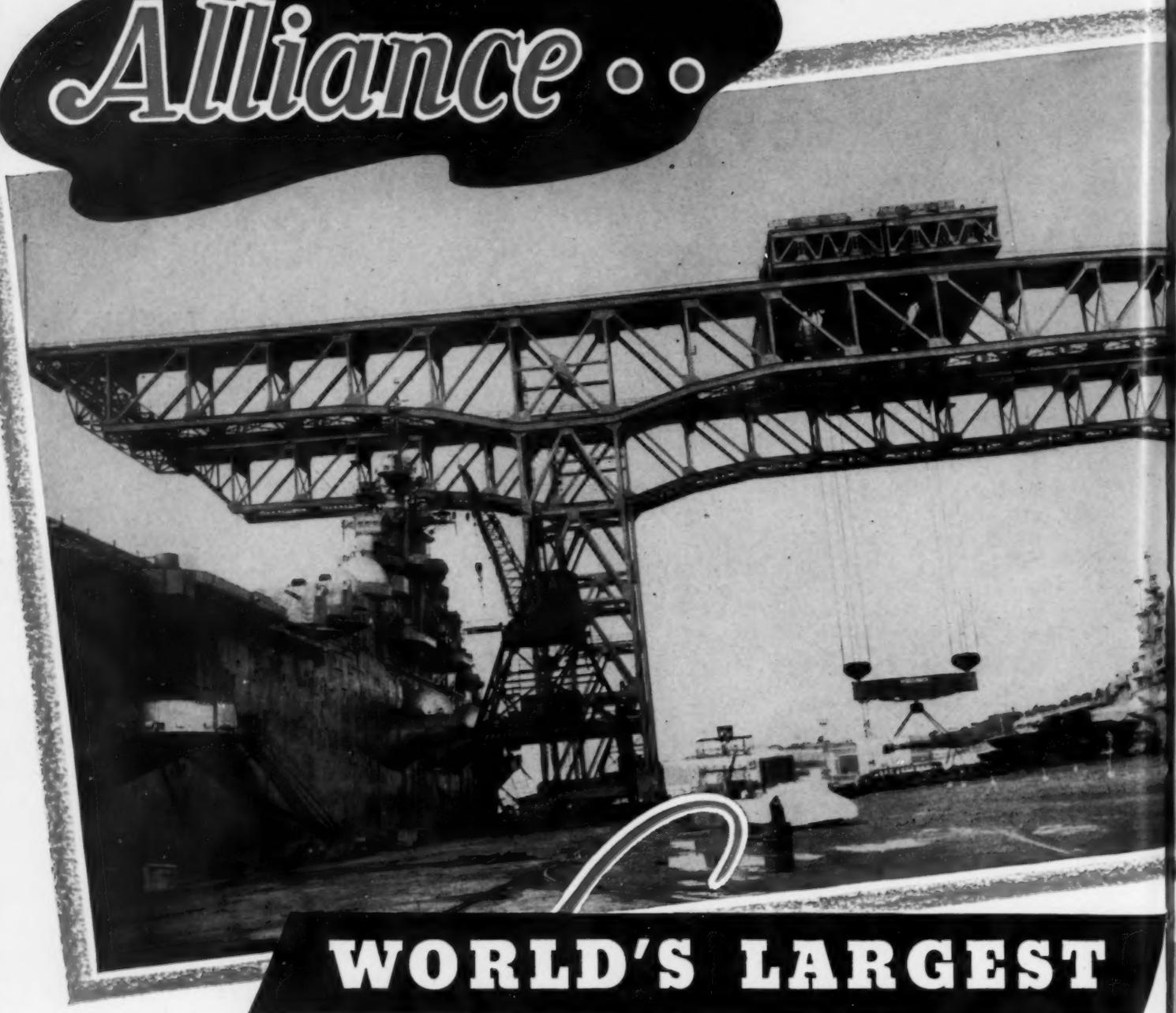
These production economies reflect GASMACO's 45 years' experience in industrial furnace engineering and manufacture—experience available to you on your next heat-treating job.

THE GAS MACHINERY COMPANY

16130 WATERLOO ROAD
CLEVELAND 10, OHIO

Designers • Fabricators • Erectors
Gas Plant Equipment and Industrial Furnaces

Alliance . .



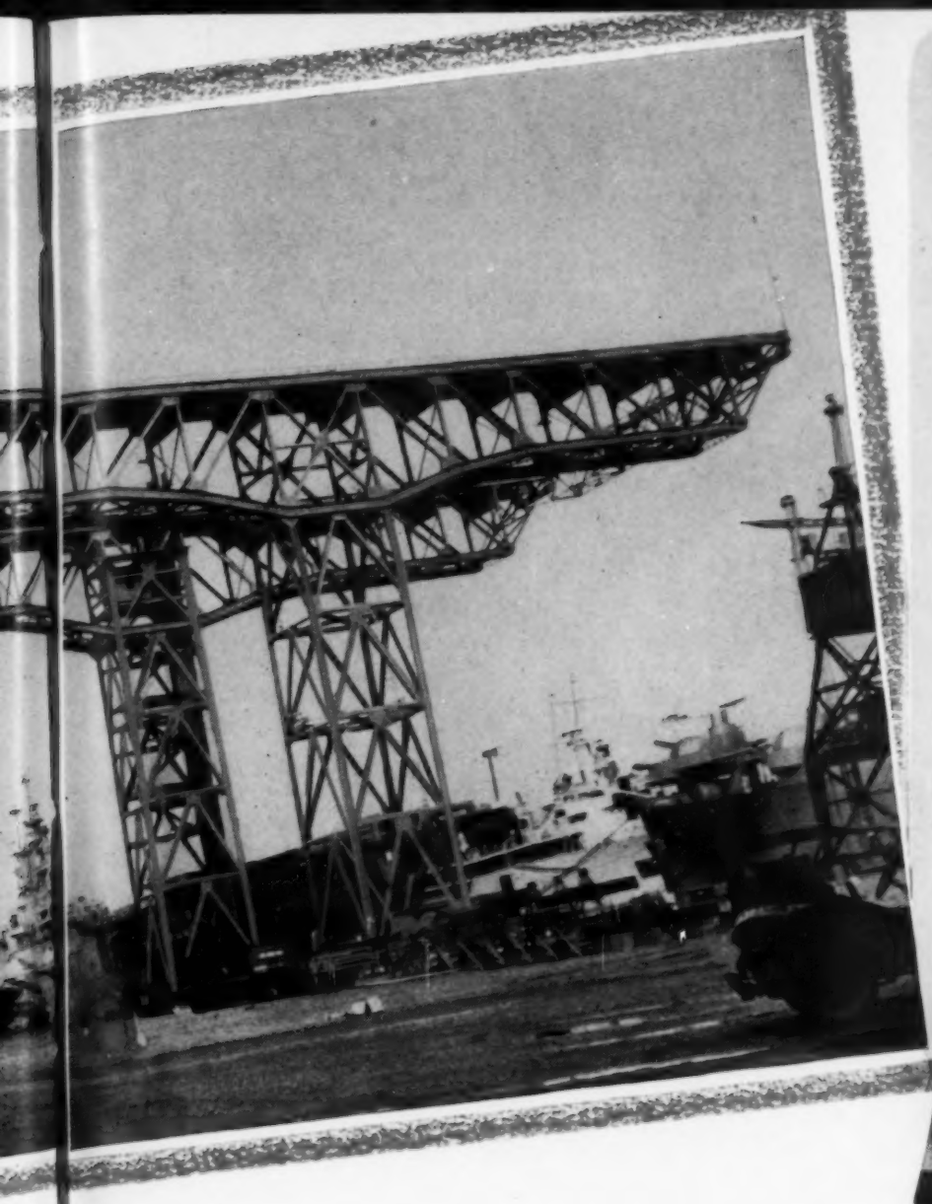
WORLD'S LARGEST Crane

You'll find the world's mightiest crane spanning the Navy's mole at Hunter's Point, California. It's an Alliance, of course, and is so big and powerful that it can easily pick up a 500-ton battleship gun turret. (Formerly, in repairing major ships of the Fleet, it was necessary to dismantle a turret, and hoist one piece ashore at a time—a long, tedious process.) This twin giant crane was recently put to its biggest test when it lifted a 630-ton metal-and-concrete block, and set it down so gently on a hen's egg that only the shell was cracked. Then the block was eased downward again, just enough to break the shell without injuring the yolk!

This rugged crane with the amazing precision control is so large that it has its own electric sub-station, aerial beacons to warn aircraft away, and a

THE ALLIANCE MA

MAIN OFFICE
ALLIANCE, OHIO



Unusual Features

OF THE WORLD'S LARGEST CRANE:

Lifts up to 630 tons with ease.

Elevation top of trolley is 207 feet above the water.

Overhead traveling cranes are mounted on a runway 730 feet long.

Each crane contains a traveling trolley from which is suspended one main and one auxiliary hook.

The two cranes can be coupled together electrically and also by means of standard railroad car couplers, so that they can be moved along the runway as one unit by one operator. The main hoist hooks of the two cranes are pin-connected to the ends of a lifting beam, which combines the lifting capacity of both cranes through 500-ton sister hooks trunnioned to the center of the lifting beam.

Direct current motors on the trolleys operate the hoisting drums, obtaining their power from a motor generator set located on the trolley.

Each main hook is supported by 24 parts of 1-3/8" steel rope, and has a rated capacity of 275 tons. More than a mile of hoisting rope is required for the main hoist four part reeving.

The main hoist hooks can reach 25 feet below the water line and lift loads 160 feet into the air. The auxiliary hoist has a lift of 220 feet.

The main hoists are of the synchronized worm drive interlocked drum type, and are driven by two motors. This type of drive was specified by the Navy and was chosen for its greater inherent safety. It is the type of drive used exclusively on all Alliance ladle cranes.

makes the heaviest lift ever known *with Amazing Precision Control*

short-wave radio for communication between the operating crews. Its huge runway is built across a special mole or pier, and its two cantilevers extend 162-1/2 feet out over the water on each side of the mole, towering high above battleships or aircraft carriers berthed below it. The bridge span of the crane is 142 feet center to center of rails and the span of the trolley 20 feet.

Of course, Alliance builds smaller cranes, too . . . all sizes, in fact, to help move heavy loads quickly, safely and easily. Always rely on Alliance to give your plant the economical, extra lifting power you need.

LADLE CRANES · GANTRY CRANES · FORGING MANIPULATORS
SOAKING PIT CRANES · STRIPPER CRANES · SLAB AND BILLET
CHARGING MACHINES · OPEN HEARTH CHARGING MACHINES
SPECIAL MILL MACHINERY · STRUCTURAL FABRICATION

ACHINE COMPANY

PITTSBURGH OFFICE
1622 OLIVER BUILDING, PITTSBURGH, PA.

(*Continued from page 131*)

field tests, extending over a period of four years, on applications such as billet cranes, open hearth chargers, etc. in large steel mills, the clamp-on linings gave several times the life of riveted linings of the same material. In addition, on the brakes tested, there was no apparent scoring of the brake wheel.

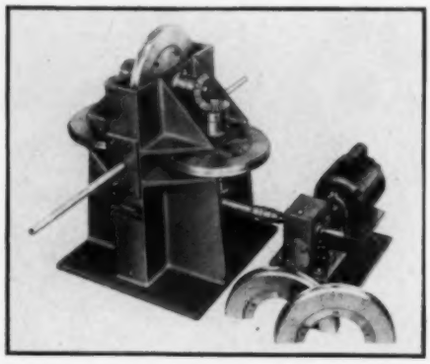
Renewal of this new brake lining is accomplished without removing the brake shoe, by simply releasing the brake and loosening the single socket head screw of the jack clamp. This allows sliding the lining from the shoe and inserting the new lining in place. Tightening the socket head screw forces the brake lining into the curvature of the shoe and the brake is ready for service.

DEVICE MARKS 4 SIDES AT PRODUCTION SPEEDS

▲ Manufacturers of seamless and light-wall aluminum, copper and brass tubing can now efficiently mark up to four sides of their products at production-line speed with a new marking device offered by Pannier Brothers Stamp Company.

This is the first time such equipment has been made available to industry.

The "Master Marker" universal marking machine stamps 1, 2, 3 or 4 sides on the same run at a rate up to 300 fpm. It handles bars as well as tubing — in round, square, hexagon and other shapes — in sizes from ⅜ to 2 in. diameter. Portable or stationary, and equipped with a ⅓ hp motor, it can be used for production or job work. It has replaceable segments, and interchangeable type, if required. Character size depends on requirements of the product marked.



The weight of this new Pannier marking device is about 700 lb complete.

Originally developed to mark mechanical tubing for electrical use, its stamping meets Underwriters' Laboratories specifications.

LIFTING MAGNET HAS WELDING IMPROVEMENT

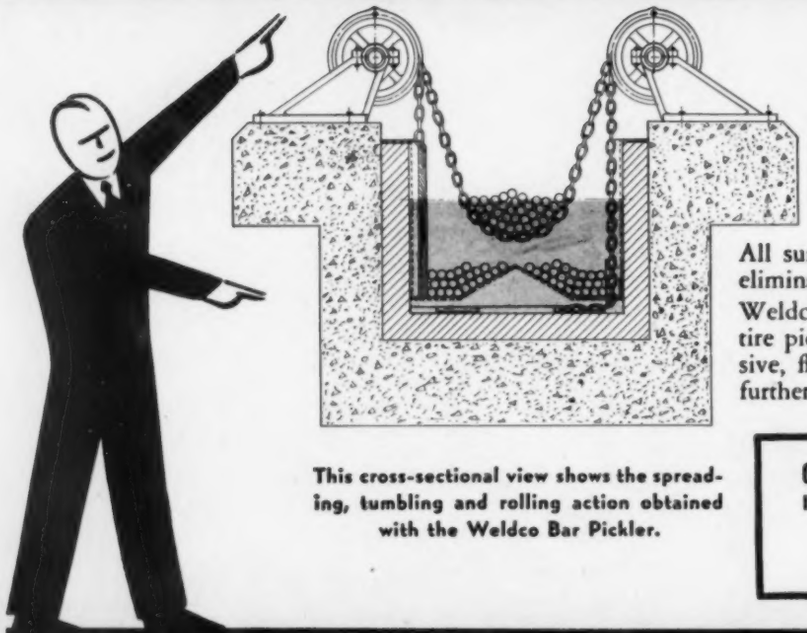
▲ A lifting magnet employing a new type of welded construction is announced by Ohio Electric Manufacturing Company.

Outer ring and top plate are welded together on top of the new magnet. This method places the weld in a position where it cannot be cracked or damaged by frequent blows against the outer ring, principal cause of weld failures in conventional magnets.

By eliminating the danger of cracks in the weld, the magnet remains hermetically sealed against moisture indefinitely.

Three magnet sizes with the new "Protecto-Weld" construction are now in production. The 39-in. diameter magnet weighs 2800 lb. The 4-coil, 55-in. diameter magnet weighs 6800 lb. The 4-coil, 65-in. diameter

For economical, time-saving pickling
the New WELDCO Mechanical Picklers
save Man power, Maintenance and Money



This cross-sectional view shows the spreading, tumbling and rolling action obtained with the Weldco Bar Pickler.

If you're pickling round, hexagon or square bars, coils, flats, tubing or sheets, the Weldco Mechanical Picklers are your best bet to increase tonnage at reduced cost. Easy to operate and control, the Picklers save 40 to 60 percent pickling time by combined mechanical agitation and chemical action, and eliminate the use of an overhead crane and operator. All surfaces are equally exposed and over-pickling is eliminated by a pre-determined cycle.

Weldco engineers can furnish all facilities for your entire pickling department, including our new, inexpensive, floor-operated crane. Write or phone today for further information.

OTHER WELDCO PICKLING PRODUCTS
Include Pickling Crates, Baskets, Chains, Hairpin Hooks, Jets, and Scrubbers.
CATALOGS AVAILABLE ON REQUEST

THE YOUNGSTOWN WELDING & ENGINEERING COMPANY
3700 OAKWOOD AVENUE . . . . YOUNGSTOWN 9, OHIO

New 55-in. lifting magnet has weld on top plate to protect weld against damaging blows and assure hermetic seal against moisture.

magnet weighs 10,200 lb. Each of the latter two sizes are also available with 6 or 8 coils that give extra lifting strength.

These new magnets are equipped with chain pins that fit into chain ears with square holes to eliminate friction and prolong life. Cable connectors are of a special Ohio design. To withstand severe abuse, the weatherproof insulated shell is made of iron. Bayonet joints for hand operation save time in making and breaking connections. Shielded contacts provide safety from arc.

10,000 HP IN MOTORS FOR COAL CLEANING PLANT

▲ Westinghouse has been awarded a contract to furnish all the major electrical equipment for a coal cleaning plant to be built by the Jones and Laughlin Steel Corporation to serve its consolidated No. 4 and No. 5 coal mines at Vestaburg, Pennsylvania. The plant is designed to produce 18,000 tons of washed coal daily which makes it the largest coal cleaning plant to be built by private capital. This output will require equipment to handle 26,000 tons of raw coal.

More than 10,000 hp in electric motors will be required to operate the plant.

ENGINEERS WITNESS TEST AT AIR REDUCTION

▲ Over 100 engineers of leading industrial organizations throughout the United States witnessed an unusual test of various metal experimental vessels at liquid nitrogen temperatures of below —300 F, recently staged here at the Air Reduction apparatus research laboratory. The various metals tested were; 8½ per cent nickel steel, AISI 2800; stainless steel, type 304; and carbon steel, ASTM A201.

The development of 8½ per cent nickel steel has created wide interest among the users of vessels that are required to operate at liquid air temperatures, and although laboratory tests at —320 F on welded and unwelded specimens indicated a considerable degree of toughness at the temperature of liquid nitrogen, it was decided to build several small vessels and subject them to a test at a temperature of below —300 F.

Results of the test showed no material damage to 8½ per cent nickel steel and stainless steel vessels, while a carbon steel vessel was shattered upon the first impact. The vessels were fabricated from these materials with all major joints being X-rayed for defects, as well as being subjected to a 700 lb hydrostatic test.

The test consisted of dropping a weight on the vessels while filled with liquid nitrogen. For the 8½ per cent nickel steel and stainless steel vessels, a weight of 292.9 lb was dropped from

For Economical Material Handling

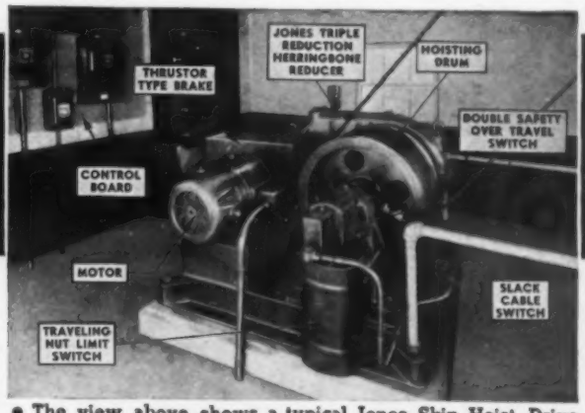
JONES SKIP HOIST DRIVES

FOR speedy operation, reliable service and over-all economy the Jones Skip Hoist Drive has made a name for itself in a wide variety of material handling service. These skip hoist drives are built as complete units by the Jones organization in several types with base to take any motor specified by the purchaser. They are equipped for all the modern protective devices such as cam or nut type limit switches, solenoid or disc type brakes and slack cable switches. The drives are single, double, or triple reduction Jones Herringbone Speed Reducers, built to stand up under the many years of pounding that a skip hoist drive has to take. The shafts are supported in roller bearings, with rolling action, rack generated gear and pinion teeth to insure easiest possible starting with low starting-peak loads. All reducer bearings and gears are automatic oil-bath lubricated.

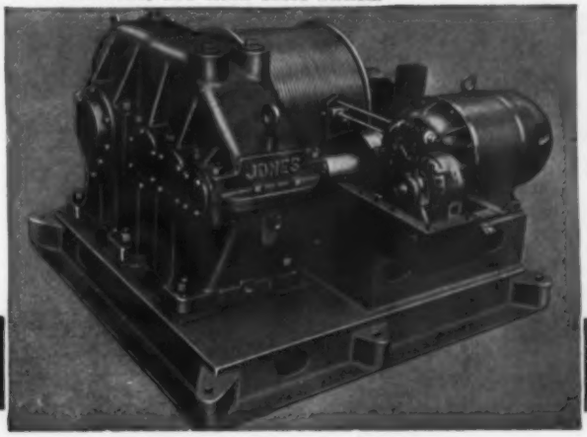
The Jones organization has an extensive file of information on skip hoist drive problems and will be pleased to work with you on any problems involving such applications.

W. A. JONES FOUNDRY & MACHINE CO.
4431 Roosevelt Road, Chicago, Illinois

Jones — HERRINGBONE—WORM—SPUR—GEAR SPEED REDUCERS · CUT AND MOLDED TOOTH GEARS · V-BELT SHEAVES · ANTI-FRICTION PILLOW BLOCKS · PULLEYS · FRICTION CLUTCHES · TRANSMISSION APPLIANCES



• The view above shows a typical Jones Skip Hoist Drive installation while the view below shows one of the Jones units equipped with traveling nut type limit switch, motor actuated brake, and slack cable switch.



Severe damage to carbon steel vessel after a weight of 184.9 lb was dropped from height of 5 ft at a temperature of below —300 F.

a height of 5 ft at the intersections of the longitudinal and transverse seams; at two locations along the longitudinal seam; and on the flange of the nozzle. For the carbon steel vessel, a weight of 184.9 lb was dropped 5 ft near the longitudinal seam about midway between one end and the nozzle.

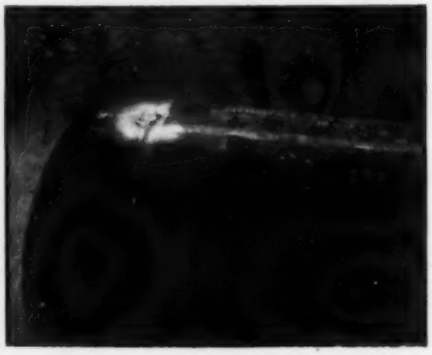
While 8½ per cent nickel steel was commercially developed primarily for engineering structures at low temperatures, it is being found to possess a versatility which fits it for a wide variety of applications at normal temperatures as well.

There are numerous fields for which the alloy is either being considered or is already being used. Limited experience indicates that it probably will find wide use for sucker rods in certain types of corrosive oil wells and for oil well tubing in deep wells.

In connection with corrosion resistance, however, the 8½ per cent nickel alloy cannot be considered as a substitute for the 18–8 types of chromium-nickel stainless steels. It may be suitable for applications involving a particular type of corrosion. Nor is it suggested as a replacement for the low alloy steels for applications in which high strength is the primary consideration.

While the test was sponsored by International Nickel Company, Inc., it was conducted by the staff of the Air Reduction apparatus research laboratory.

Nickel (8½ per cent) steel vessel showing minor effects of dropping a weight of 292.2 lb from a height of 5 ft at —300 F.



NEW CONNECTOR REPLACES 32 PARALLEL UNITS

▲ One typical connector of a new XTP line replaces up to 32 different parallel or tee connectors, according to O. Z. Electrical Manufacturing Company. Available in twenty-five sizes, accommodating over 400 wire combinations ranging from No. 8 to 1,000,000 cir mil the XTP will do practically all tap jobs. Further, the wide range of the XTP reduces the number of connector types users need carry in stock.

The one-piece, hinged construction

FOR A GROUP OF OIL BURNERS OF SMALL CAPACITY

BLOOM UNIT ATOMIZER

Provides a Method of Burning Small Quantities of Heavy Fuel Oil at Each Burner

The atomizer operates on high pressure steam. It atomizes a reasonable quantity of oil and then divides and distributes this quantity into equal parts, which are delivered to a number of small burners.

An easy system to control. A workable method for a combination oil/gas application to small gas burners. Suitable for oil application to burners requiring 1½ to 3 g.p.h.

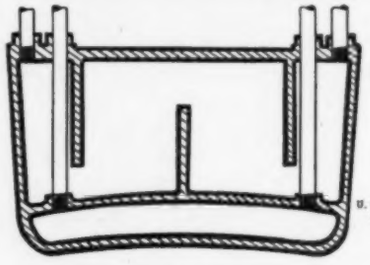
BLOOM ENGINEERING CO.

857 W. North Avenue Pittsburgh 12, Pa.

A QUICK LOOK

At the Advantages of the

DOBSCHA DOUBLE COMPARTMENT COOLING PLATE



U. S. PAT. NO. 2,311,819.

A GLANCE at the accompanying illustration will reveal the two prime advantages of the Dobscha Cooling Plate:

1 The "NOSE" compartment may be sealed off, in event of "burning," **without reducing** the cooling area of the large volume "BUTT" compartment.

2 Direct feed and discharge affords **high velocity** water travel through the nose, eliminating clogging due to bad water sediment.

Get THESE "PLUS VALUES" WITH THE DOBSCHA FROM FALCON

● Falcon casts the Dobscha Plate vertically, **without** anchors or chaplets, "NOSE" down, so the densest metal is in the "NOSE" where needed.

Falcon installs the copper "Feed" and "Discharge" pipes to the nose compartment.

Falcon **ships** each Dobscha Plate in a **special** crate or cradle which protects these nose "Feed" and "Discharge" pipes in shipping and handling between the foundry and your furnace wall.

Falcon is licensed to make and sell the Dobscha Plate. U. S. Pat. 2,311,819.

TELEPHONE COLLECT • 3-4355

FALCON BRONZE CO.

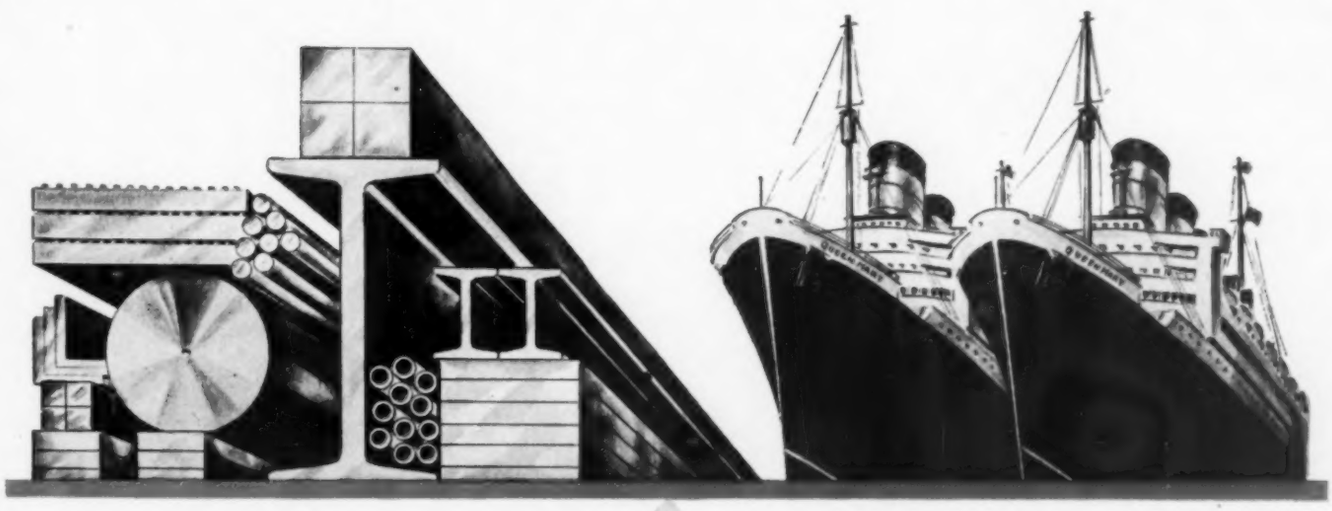
YOUNGSTOWN 3, OHIO

Established 1890 • Incorporated 1895

B&W JUNIOR FIREBRICK

help increase steel output by

162,000 tons



More than

TWICE

the weight of the

QUEEN MARY!

Production figures show that remarkable savings are being realized through the use of B&W Junior Firebrick.

For example, the first quality firebrick in the suspended roof of a continuous reheating furnace had to be replaced after heating every 45,000 tons of steel. But—when the roof was rebuilt with *B&W Junior Firebrick*, 207,000 tons were run through without shut-down for repairs! And, at the end of the run, the roof was thin but otherwise in good condition.

B&W Junior Firebrick help you increase output and reduce costs by reducing the refractory replacement rate and by eliminating frequent furnace outages. Your local B&W Refractories Engineer will be glad to discuss your refractories problems.

R-304

B&W REFRACTORIES PRODUCTS

B&W 80 FIREBRICK • B&W JUNIOR FIREBRICK
B&W 80 GLASS TANK BLOCKS • B&W INSULATING FIREBRICK
B&W REFRACTORY CASTABLES, PLASTICS AND MORTARS

•

OTHER B&W PRODUCTS

Stationary & Marine Boilers and Component Equipment
Chemical Recovery Units . . . Seamless & Welded Tubes . . . Pulverizers
Fuel Burning Equipment . . . Pressure Vessels . . . Alloy Castings

BABCOCK & WILCOX

THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 85 LIBERTY ST., NEW YORK 6, N.Y.
WORKS: AUGUSTA, GA.

of this new connector makes for speed and simplicity in installation. It can be permanently attached to the main and left for the tap to be attached later. One end of the connector is simply snapped over the main and tightened, the other has serrated openings to which a tap can be run in any of three directions.

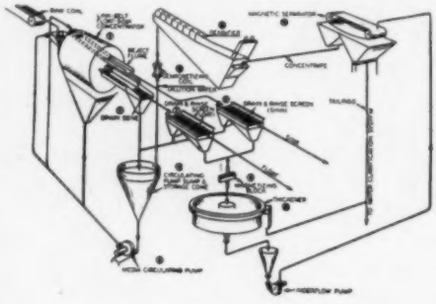
Other advantageous construction features are: spring steel lock washers (tin plated) maintain permanent pressure; grip holding serrations on wire-contact surface for maximum pull out strength; non-rotating pressure plates; highly conductive copper alloy body; extra strength copper alloy hinge and pressure plates.

The manufacturer says that the new XTP connectors will soon be on hand in all sizes at O. Z. distributors coast-to-coast.

LINK-BELT DEVELOPS FLOAT-SINK CLEANER

▲ In keeping with Link-Belt Company's steadfast policy of not advertising a new product until it has been thoroughly tried-out and proved in actual service, Link-Belt engineers now announce that they have developed a new float-sink concentrator for cleaning coal, ores and similar materials by the heavy-media method of separating and removing the rejects.

This new Link-Belt float-sink cleaning process has been in use for a considerable time in a coal preparation plant in Pennsylvania, with such satisfactory results that the company has recently entered into contracts to install float-sink concentrators and



allied equipment at other operations.

The separating medium employed in cleaning coal is composed of a mixture of water and finely-ground magnetite, proportioned to give the desired separating gravity.

The process has a high operating efficiency, particularly when a large percentage of the material handled is near the separation gravity.

It produces a clean "float" with a minimum of "sink" material or rejects in it; and a clean "sink" containing a minimum of "float" material.

It is especially adapted for use where sharp separations must be made at a low specific gravity. The range extends as low as 1.25 specific gravity.

It is also adapted to cases where the amount of impurities in the coal-feed fluctuates widely. It maintains its efficiency through such fluctuations without adjustment.

It has the ability to handle the larger sizes of coal (above the usual 6-in. range), thereby reducing the necessity for manual picking.

When necessary to meet changing demands or characterstics of the coal to be cleaned, the specific gravity of the medium can be regulated immediately to suit the new operating conditions.

This type of cleaning plant may be started and shut down quickly and easily, without loss of clean coal or loss of operating efficiency.

The new concentrator is the heart

SAFER, FASTER MARKING with the **SAFETY BOX TYPE HOLDER**

The Safety Box Type Holder for safe and efficient marking of hot or cold, flat, round or angular surfaces—is made of one piece of Safety steel with welded handle, for heavy duty service. Outer sleeve holds type holder at right angles to surface, assuring perfect impressions. Type is quickly and easily changed.

• NO MUSHROOMING • NO SPALLING
• BETTER MARKING • LONGER SERVICE LIFE

Write for Complete Data

M.E. CUNNINGHAM CO.
SAFETY STEEL STAMPS
105 E. CARSON STREET PITTSBURGH 19, PA.

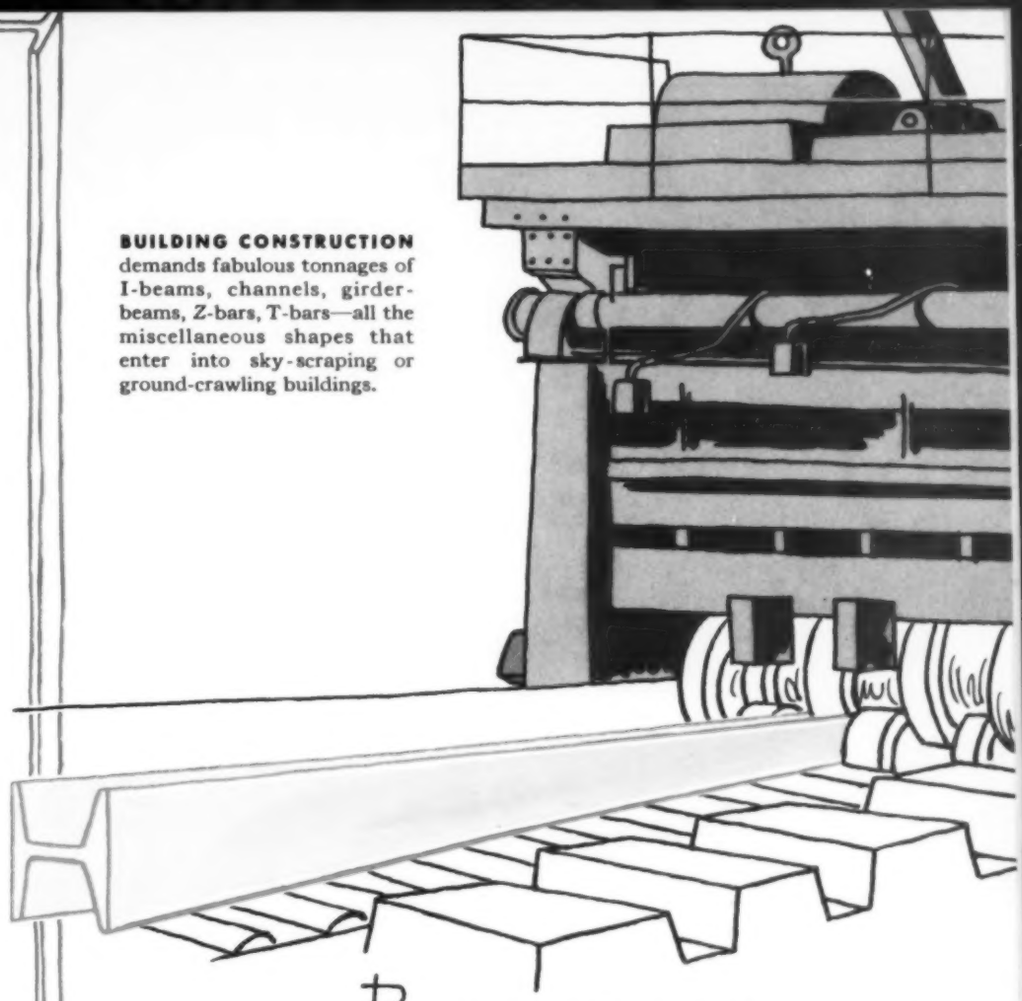
BLAST FURNACE COPPER CASTINGS

Bosh Plates
Mantle Plates
Cinder Notches
Tuyeres
Tuyere Coolers
Hot Blast Valves
and Valve Seats

SMEETH-HARWOOD COMPANY
2401-09 West Cermak Road, Chicago 8, Illinois
Superior Blast Furnace Copper Castings Exclusively

A.

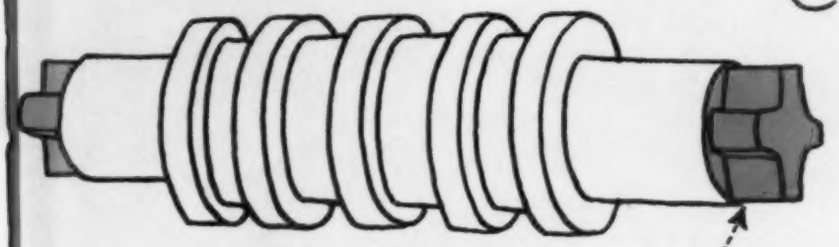
BUILDING CONSTRUCTION demands fabulous tonnages of I-beams, channels, girder-beams, Z-bars, T-bars—all the miscellaneous shapes that enter into sky-scraping or ground-crawling buildings.



B.

EACH STRUCTURAL SHAPE, each rolling-mill specification, calls for the ultimate skill on the part of the operator—the technique accumulated through years of trial-and-error development, and the transfer of that know-how from generation to generation.

C.



RED WABBLER ROLLS have been developed through those same trial-and-error steps because your own skill and rolling-mill knowledge has guided Mack-Hemp engineers—your own rigid demands for perfection in finish, and for production capacity, have inspired the metallurgical and mechanical improvements which make Red Wabbler Rolls progressively better, year after year.

D.

MACK-HEMP CRAFTSMEN and mill-wise M-H engineers continue to combine their skills to supplement your know-how in the design, metallurgy and manufacture of Red Wabbler Rolls—the proper rolls for your production rolling operations.

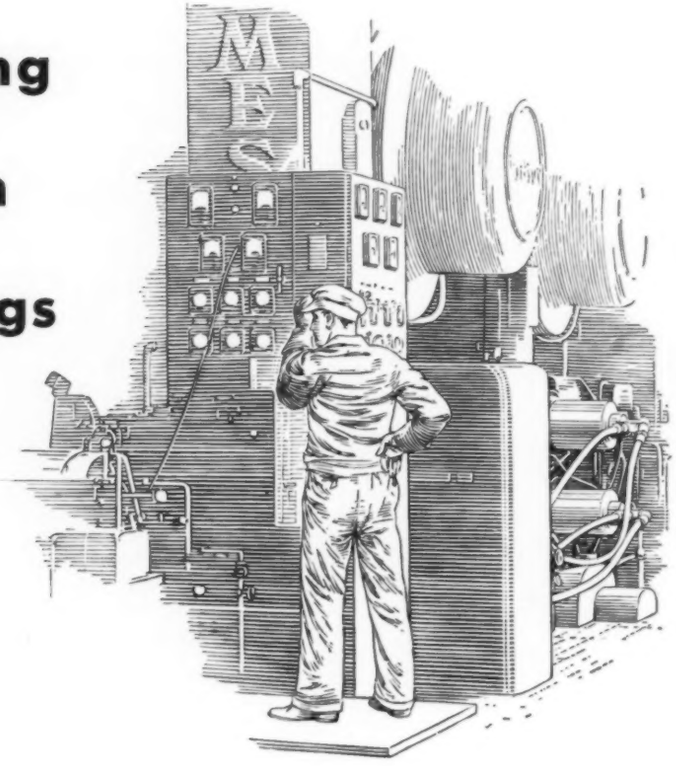
Makers of the rolls with the red wabblers

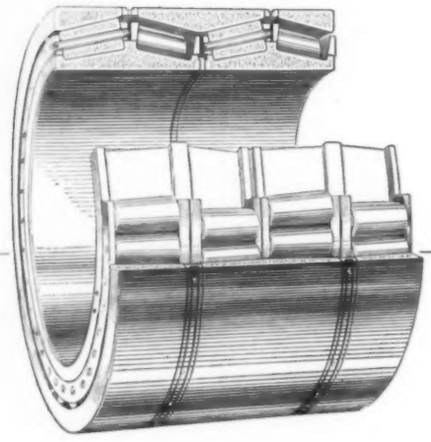
MACKINTOSH-HEMPHILL CO.

PITTSBURGH AND MIDLAND, PA.

Mesta hot strip mills incorporate the many advantages of Torrington Roll Neck Bearings.

Continuous Rolling With Torrington Roll Neck Bearings





... higher load factor—an advantage possible because of proportioned design and high radial and thrust capacity of Torrington four-row Tapered Roller Bearings.

AS EACH SLAB slams through the stands, you can count on Torrington Bearings to keep the mill rolling out record tonnages. Here are the reasons why: Provision is made for greater strength in roll necks as well as in the bearings... Increased neck diameters are allowed by the minimum cross-section... Closer spacing of rollers means higher radial and thrust capacity to handle heavy shock loads. These features, together with the efficient lubrication system provided in the bearing design, assure maximum service life.

Assure yourself this kind of performance on work rolls, back-up rolls, screw downs, edgers, shears, table rolls and pinion stands by ordering Torrington Bearings for your equipment.

For follow-through service, call on the specialized skills of Torrington's engineers, who have had extensive experience in designing, building and applying anti-friction bearings in the steel industry. Call or write the nearest Torrington office.

THE TORRINGTON COMPANY

South Bend 21, Ind. • Torrington, Conn.

District Offices and Distributors in Principal Cities

TORRINGTON BEARINGS

SPHERICAL ROLLER
TAPERED ROLLER
STRAIGHT ROLLER
NEEDLE
BALL
NEEDLE ROLLERS

of this heavy-media method of separation. It requires only one operator; entails low operating and maintenance cost; and requires only a relatively small capital outlay for its installation.

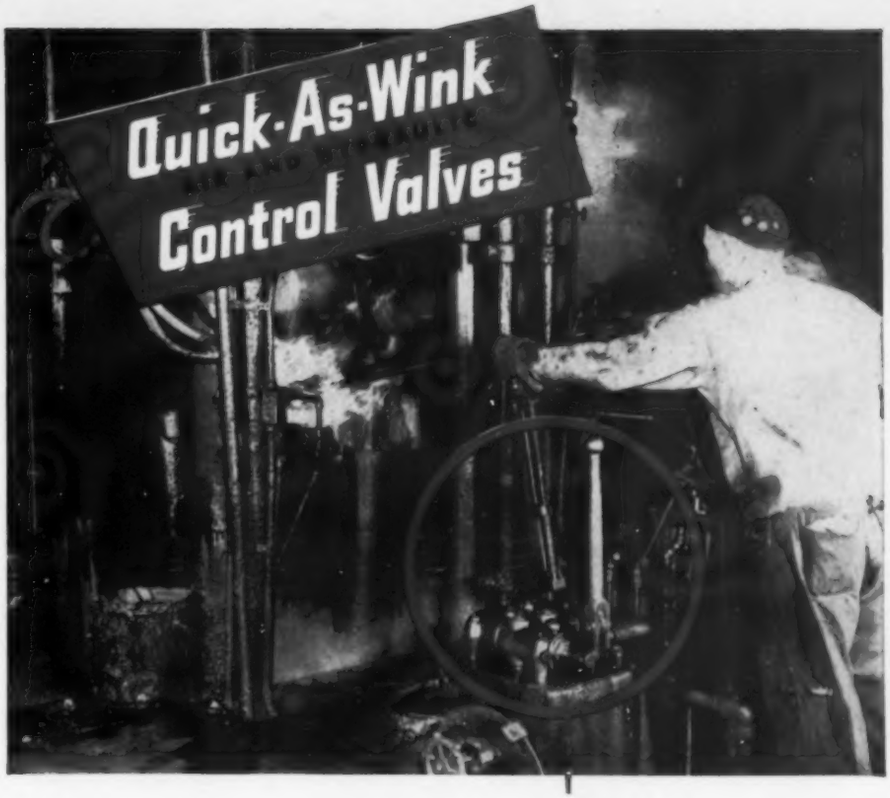
OXYGEN PILOT PLANT PROVES SUCCESSFUL

▲ The successful development of a new process for the manufacture of relatively pure gaseous oxygen in tonnage quantities is announced by the Elliott Company. A pilot plant, which has been operating for more than two months, has proven that the Elliott process can operate indefinitely without the necessity of periodic "defrosting" shutdowns, thus overcoming one of the big disadvantages of similar plants which are unable to stay on stream continuously.

In the process of making oxygen, preconditioned air is cooled to below minus 300 degrees F, and distilled in a special distillation column into its components, oxygen and nitrogen. The oxygen is then piped to the process where it will be used. The

SOUTH WORKS' FURNACES NEARLY COMPLETED

Men working on U. S. Steel's construction and modernization program, which has totaled $775 million since V-J Day are building one of the largest blast furnaces in the world. Soon they will celebrate the completion of this and a second similar furnace at the South Chicago, Illinois, works of Carnegie-Illinois Steel Corporation. A third recently was placed in operation by crew men at the Gary, Indiana, works of Carnegie-Illinois. Erectors of steel on these and other projects are increasing by one million tons a year the blast furnace capacity of U. S. Steel.

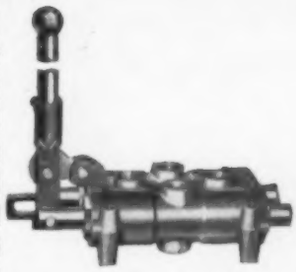


Service built in beneath the surface

● It isn't what you see—but the working parts you can't see that's important about control valves.

Positive and fast acting with U-shaped packers that are expanded by the pressure, Quick-As-Wink Control Valves seal tightly preventing leakage and bleeding. All operating parts are in pressure balance eliminating any tendency to creep or crawl. There is no lapping—no grinding—no metal to metal seating. Every valve is a high quality control—precision made—and individually tested before being shipped. This assures users a maximum of long, efficient, trouble-free service.

Furnished in hand, foot, pilot, solenoid and diaphragm operated designs for controlling all types of air and hydraulic equipment. Let us work with you on your requirements!



Quick-As-Wink Lever Operated Hydraulic Valves

The MF-651-N4 pictured above is a four-way neutral position valve, for controlling double acting cylinders. It can also be furnished with three position "compound-exhaust", or "compound-on" actions. Recommended for use with oil or water up to 150° F. and 2000 PSI. Other types for pressures up to 5000 PSI, —but send for a catalog today and get *full* details about the *complete* line.

Quick-As-Wink Control Valves

THE HIGHER THE PRESSURE THE TIGHTER THE SEAL

Manufactured by **C. B. HUNT & SON, Inc.,** *Salem, Ohio.*

Engineering and Sales Representatives in the Principal Cities

nitrogen from the Elliott process is so pure that it can also be used as a chemical raw material or for bright annealing in steel mills.

The possibilities of these oxygen plants are very intriguing and commercial plants are envisioned which will produce more than 25,000,000 cu ft (1000 tons) of oxygen per day. Oxygen on a tonnage basis is a new tool in the steel industry. It is expected that with the use of oxygen the output and economy of open hearth furnaces, blast furnaces, bessemer converters and electric furnaces can be greatly increased.

Quantity oxygen is also an essential of the new synthetic gasoline processes which are being planned. The use of oxygen combined with natural gas opens up a new source of supply of much needed gasoline, fuel oil and chemicals. Coal can also be used instead of natural gas, in the production of gasoline, fuel oil, etc., and this development can make the United States entirely independent of the rest of the world for liquid fuels for possibly as long as a thousand years. Even substitute natural gas can be made right at the mines by the gasification of coal through the use of oxygen, and piped to large cities and industries.

The pilot oxygen-generating plant at Elliott Company represents more than two and a half years of work, involving the use of new materials and equipments, many of which have to operate under exceedingly low temperatures.

It is emphasized that the Elliott plant is an American process, designed according to American engineering principles and not tainted with European ideas. It overcomes disadvantages of the Linde-Frankl type process which was developed in Germany and modifications of which are proposed in the United States.

Engineers representing a number of prominent companies currently investigating processes involving the use of oxygen have witnessed the Elliott pilot plant in operation.

S. P. KINNEY NAMES ALABAMA REPRESENTATIVE

▲ Shook and Fletcher Supply Company of Birmingham, Alabama, have been appointed sales representatives for the state of Alabama for the sale of blast furnace and steel plant equipment by S. P. Kinney Engineers, Inc., of Pittsburgh, Pennsylvania.

Book Reviews

▲ The following new standards were recently issued by the NEMA:

1. "NEMA Standards for Asbestos,

PEERLESS

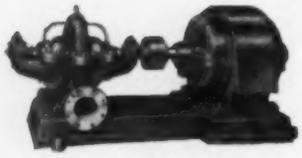
HORIZONTAL CENTRIFUGAL PUMPS

For Most Services In All Industries

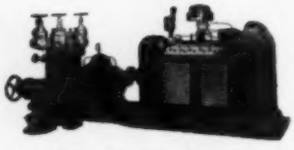
FOR CONTINUOUS DUTY GENERAL SERVICE PUMPING

Peerless Type A Pumps

Capacities: Up to 70,000 G.P.M.
Heads: To 300 ft.
1 to 1000 H.P.
All Types Drive.



TYPE A SINGLE STAGE PUMP



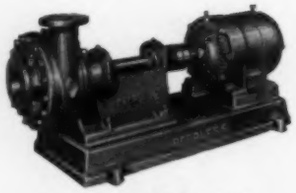
TYPE AF WITH COMPLETE FITTINGS

FOR ACIDS, CAUSTICS, HOT OILS, CHEMICALS AND PROCESS SERVICES...

Peerless Type C Pumps

Capacities: 10 to 1,200 G.P.M.
Heads: Up to 100 lbs.
1 to 60 H.P.

Request Bulletins On The Type Required For Your Applications.



TYPE C SINGLE STAGE PUMP

FOR ADEQUATE FIRE PROTECTION SERVICE

TYPE AF FIRE PUMPS*

Underwriters' Approved

Capacities: 500 to 2000 G.P.M.
Pressure: Up to 150 lbs. – 20 to 250 H.P.

*Formerly Dayton-Dowd

PEERLESS PUMP DIVISION

Food Machinery Corporation

Factories: Los Angeles 31, Calif.; Quincy, Ill.; Indianapolis, Ind.
District Offices: New York 5, 37 Wall St.; Chicago 40, 4554 No. Broadway; Atlanta Office: Rutland Bldg., Decatur, Georgia; Dallas 1, Texas; Fresno, California; Los Angeles 31, California

Asbestos-Varnished-Cambric and Asbestos-Synthetic Insulated Wires, Cables and Cords," Publication No. 48-131. This revised publication supersedes the "Standards for Asbestos and Asbestos-Varnished-Cambric Wire and Cable," Publication No. 39-54. It covers the physical properties and testing of electrical conductors insulated with asbestos or combinations of asbestos and other insulation materials, with or without outer coverings. Strandings, diameters of bare wire, thicknesses of insulation and braid, minimum picks in outer coverings, assembly of multiconductor cables and the construction of cables are also covered in this publication. 8½ × 11½, 38 pp, $1.50.

2. "Specifying a Geared Steam Turbine Generator Unit (75 to 400 Kw, Inclusive)," Publication No. 48-129. This publication has been prepared with the object of being of assistance to purchasers in their preparation of purchase specifications for geared steam-turbine-driven synchronous and direct-current generator units rated 75 to 400 kw, inclusive. The information has been compiled in such form that the purchaser may use any or all portions as written. The specification is issued as a supplement to the "NEMA Recommended Standards for Turbine-Generator Units, 75 to 400 Kw, Inclusive," which was offered as a basis for the design and construction considered essential in a durable, reliable and efficient unit. 8½ × 10½, 16 pp, $0.75.

▲ Just published is a most important new work in the field of corrosion, "Corrosion Handbook," by Herbert H. Uhlig, Associate Professor and Director of the Corrosion Laboratory, Department of Metallurgy, Massachusetts Institute of Technology. This book is a comprehensive new reference work of paramount importance to chemists, metallurgists, and engineers in all fields. Uhlig's "Corrosion Handbook," incorporating the work of 100 outstanding authorities, has been prepared under the auspices of the Electrochemical Society and the Society's Corrosion Division. Its purpose is to provide a condensed summary of information covering all phases of corrosion, including within its scope a cross-section of scientific data and industrial experience. The major part of the content deals with corrosion prevention and the behavior of metals and alloys in various environments and at both ordinary and extreme temperatures. Emphasis is on quantitative rather than qualitative data. Current corrosion theory is covered, as is corrosion testing. The book is published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, New York, 1188 pp, $12.00.

▲ The first nationally acceptable safety provisions for the construction and operation of mechanical conveyors and conveying equipment have just been made available. Safety provisions for all types of conveyors are included in the new standard. Special provisions for safe operation are given for each type. The safety of the worker or operator is given first consideration, but the efficient use of the conveyor has also been kept in mind in selecting guards and other safety devices.

Copies of the American Standard Safety Code for Conveyors, Cableways, and Related Equipment (B20.1-1947) may be obtained for 90 cents per copy at the office of the American Standards Association, 70 East 45th Street, New York 17, New York.

You can make*

3,000 calls a day!

by Exhibiting Your Equipment

at the 1948 IRON & STEEL EXPOSITION

CLEVELAND PUBLIC AUDITORIUM
CLEVELAND, OHIO
Sept. 28, 29, 30, Oct. 1, 1948

* Over 12,000 buying officials of the steel industry will attend the steel show in four days.

phone, wire, write

ASSOCIATION OF IRON & STEEL ENGINEERS
1010 Empire Building, Pittsburgh, Pa.
ATlantic 6323

This special Pannier machine gives you PRODUCTION-LINE MARKING of SEAMLESS or LIGHT-WALL TUBING ... and stamps up to 4 sides on the same run!

ANOTHER Pannier FIRST

Now you can save money, time and labor in the efficient marking of light-wall aluminum, copper and brass tubing or bars. The new Pannier "Master Marker" Universal Marking Machine marks 'em all ... round, square, hexagon and other shapes ... in sizes from ⅜ to 2-inch diameter. It stamps 1, 2, 3 or 4 sides on the same run at the rate of 300 feet per minute. Portable or stationary, and equipped with a ½ H.P. motor, it can be used for production or job work. The new machine was originally developed to mark mechanical tubing for electrical use. Its stamping meets Underwriters' Laboratories specifications.

Write for Bulletin No. LTM-1 ... and for recommendations on *any* marking need.

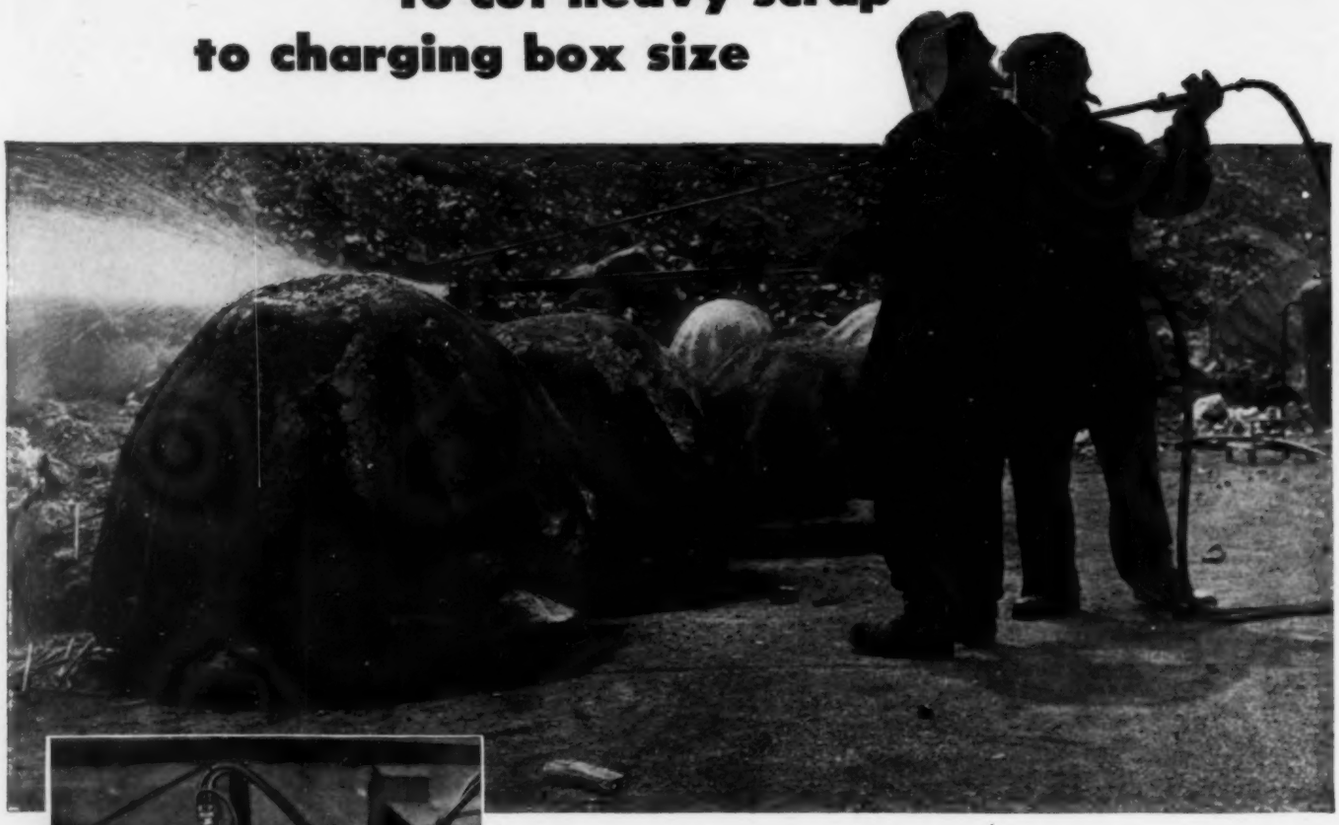
OFFICES:

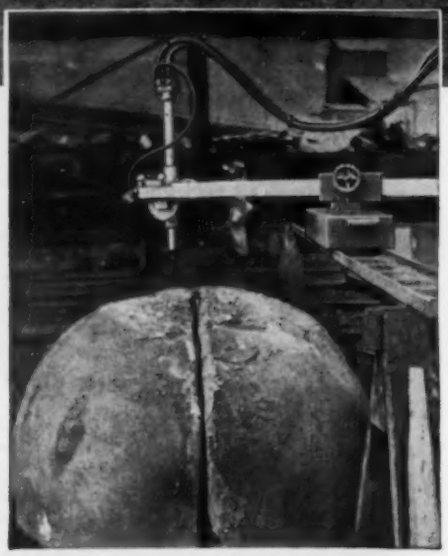
Chicago, Illinois Los Angeles, California
Youngstown, Ohio Philadelphia, Penna.

PANNIER BROS. STAMP CO.

302 PANNIER BUILDING
PITTSBURGH 12, PA.

Here are THREE economical ways to cut heavy scrap to charging box size





Today, Airco offers steel men three outstanding oxyacetylene cutting methods that permit easy and economical handling of heavy scrap. Practically any heavy scrapping job falls within their scope . . . regardless of size, shape or location.

1. ***The oxyacetylene torch, plus the oxygen lance*** **. . . The illustration above shows them being used to scrap a heavy button . . . work progresses efficiently without initial handling since chunks can be cut to size in any position.**
2. ***Machine gas cutting*** **. . . This is ideal where crane facilities are available. The setup requires a heavy duty cutting torch on an Airco No. 40 Radiagraph. The two typical skulls shown in fig. 2 were sliced in two in 45 minutes each.**
3. ***The oxygen lance*** **. . . Capable of cutting extremely large sections. In fig. 3 the lance is being used to cut a 75-ton open hearth spill.**

This is another example of the manner in which modern Airco oxyacetylene equipment is helping progressive operators slash time and costs.

Ask to have an Airco Technical Sales Division representative call to supply further information. Address: Dept. 7586, Air Reduction, 60 East 42nd St., New York 17, N. Y. In Texas: Magnolia Airco Gas Products Company, Houston 1, Texas.

AIRCO **AIR REDUCTION**

Offices in All Principal Cities

Headquarters for Oxygen, Acetylene and other gases . . . Carbide . . . Gas Welding and Cutting Apparatus and Supplies . . . Arc Welders, Electrodes and Accessories

The New

NORTH AMERICAN

Soft-seat

ATMOSPHERIC REGULATORS

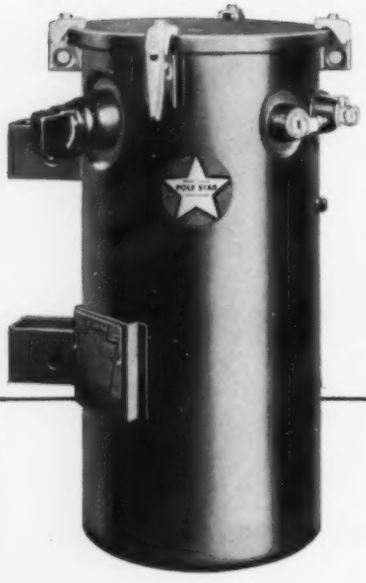
● Series 18 North American Atmospheric Regulators are designed especially for single valve control of premix gas burner systems and incorporate the new feature of a soft seat for tight shutoff when the demand for gas flow ceases. Users will find the tight shutoff feature quite advantageous in that close control can be realized at low gas flow.

● Single valve control can be used with non-premix systems by connecting the vent on the Series 18 Atmospheric Regulator to the air line downstream from the control valve. The regulator responds quickly to very slight changes in impulse line pressure.

● When the Series 18 Atmospheric Regulator is used, both premix and non-premix systems are assured proportional air-gas ratios over the entire capacity range of the regulator.

THE NORTH AMERICAN MANUFACTURING COMPANY
GAS or OIL COMBUSTION EQUIPMENT ● OFFICES in PRINCIPAL CITIES
CLEVELAND 5, OHIO

Don't Worry!
the children are safe now that they installed those POLE STAR* transformers with insulating caps on the High Voltage Bushings.



SHOULD the birds get playful and decide to use the high voltage bushings as a diving board, have no fear for the safety of the transformer, or for that matter, the safety of the birds! Our feathered friends cannot make contact with the live parts of the bushings, because no live parts are exposed.

Linemen like the sturdy, well designed POLE STAR insulating caps because they cover sharp points and edges on bushing terminals that may catch their clothes should they happen to come too close to the bushings.

Insulating caps are attached to the bushings and swing in and out of position on non-corroding spring wire hinges. Caps are self-supporting above the terminals leaving connectors completely exposed so the linemen can see the connections they are making. After connections are made with a standard wrench, the caps are closed by hand pressure which locks them in place to completely cover the bushing terminals.

Embodying a new wound core design with an inherent low exciting current, POLE STAR Transformers are made in sizes 25 Kva and below, 14400 volts and below, single phase, 60 cycles, OISC, conforming to EEI-NEMA Standards, Second Report (Revised).

To Remove:
Grasp insulating cap.
(Note streamlined appearance of cap.)

Rotate out and up.

Rest cap on top of insulator and make proper connection. Connection is fully visible and is made with a standard wrench.

To Replace Cap: Rotate downward and push back into position.

*P.S.
let the POLE STAR be your guide...
Product Of Long Experience
Safe Thrifty And Reliable

POLE STAR

Pennsylvania TRANSFORMER CO.
PITTSBURGH 12, PENNSYLVANIA

DATE-LINE DIARY...

March 1

▲ The operating rate of steel companies having 94 per cent of the steel capacity of the industry will be 94.6 per cent of capacity for the week beginning March 1, 1948, equivalent to 1,705,100 tons of steel ingots and castings, compared to 1,687,100 tons one week ago.

March 2

▲ A modernization program under way at the Vandergrift plant of the Carnegie-Illinois Steel Corporation is expected to result in 50 per cent increase in the production of silicon steel. Some outmoded steel and galvanizing facilities are being eliminated to make room for the expansion.

▲ Benjamin F. Fairless, president of the United States Steel Corporation, appeared before the joint Congressional committee on the economic report. In this appearance, Mr. Fairless stated that, "United States Steel has made no general increase in the prices of its steel products and it does not now contemplate making any such increase. United States Steel has entered into no agreement or understanding, private or otherwise, to grant further wage increases." Mr. Fairless defended the previous increase on semi-finished products as a minor adjustment on an item on which they were losing money.

March 3

▲ Inasmuch as limited controls on tin have been extended until May 30, the Commerce Department ordered the tin conservation program to take effect.

▲ Some Republican senators normally considered friendly to business are very bitter about the minor semi-finished steel price increase. They feel that further inflation will be blamed on big business.

▲ A British trade commission estimates that iron ore reserves in China are about 18,000 million tons. The bulk of the ore contains less than 50 per cent iron.

March 4

▲ The Westinghouse Electric Corporation reported that its net sales for 1947 top all previous peace time records at a figure of $703,154,334. Net income, after provision for preferred stock dividends, equalled $3.58 per share of common stock.

March 5

▲ The Timken Roller Bearing Company has advised its customers that except for a few minor items, present bearing prices will hold until June 30, 1948.

March 6

▲ Freight car production in February amounted to 8463 cars, compared with 2293 cars the year before, and 8949 cars for the previous month of January, 1948.

March 7

▲ Net sales for 1947 for the Crucible Steel Company of America were $110,000,000, compared with $88,000,000 for 1946. After payment of dividends on preferred stock, the net income was equal to $1.12 per share of common stock.

March 8

▲ The United States Commerce Department committee which is making the study on future steel requirements is under the direction of H. B. McCoy, director of the Office of Domestic Commerce and two of his assistants, R. Matthes and Dr. Robert M. Weidenhammer.

▲ The operating rate of steel companies having 94 per cent of the steel capacity of the industry will be 96.6 per cent of capacity for the week beginning March 8, 1948, equivalent to 1,741,200 tons of steel ingots and castings, compared to 1,705,100 tons one week ago.

March 9

▲ General Electric Company announced that it would refuse any wage increase for its 100,000 workers because such an increase would be inflationary.

▲ The Associated Press weighted wholesale price index of 35 commodities dropped to a new low of 185.58.

March 10

▲ Joseph H. Carter, president of Pittsburgh Steel Company, stated in his annual report that when the new blast furnace which they acquired from the government comes into operation, the company expects to gain material advantages "by replacing a substantial portion of its purchased scrap with iron at a considerably lower cost."

March 11

▲ In January 1948, according to the American Iron and Steel Institute, steelworkers in iron and steel plants received an average of six cents more per hour than their average hourly rate in 1947. The January figure was about $1.57 compared with $1.51 for the previous year.

March 12

▲ United Engineering and Foundry Company stated that unfilled orders are not only at a new high for all time, but are sufficient to permit the company's plants to operate at capacity production for several years to come. They stated also that new developments in the field of processing and finishing equipment include several electrolytic lines for the production of tin plate, which have operated at speeds in excess of 1000 feet per minute.

March 13

▲ The Texas Eastern Transmission Corporation applied to the Federal Power Commission for permission to construct and operate a 26-inch pipe line parallel to its Big Inch pipe line for the purpose of bringing natural gas from the Southwest to gas distributing companies on the eastern seaboard and Appalachian area. The eastern terminus of the line would be at Wind Ridge, Pennsylvania, where it would tie in with the existing lines.

March 14

▲ Allied control authorities in Germany raised the target of steel production for 1948 from 4.8 million tons to 6 million tons.

March 15

▲ The Reconstruction Finance Corporation authorized a $3,000,000 expansion at the Fontana, California steel plant of the Kaiser Company, Inc. Most of this expansion will be used for open hearth operations.

▲ The Allegheny Ludlum Steel Corporation announced that its plant improvement program which has been under construction since August, 1945, will cost $24,000,000 instead of the $15,000,000 originally estimated. The changing costs are largely due to inflation in prices. This cost increase was also the reason for the company requesting authority from its stockholders to issue 200,000 shares of cumulative preferred stock as well as additional common. The stock will not be issued if the money can be raised through a loan.

▲ The operating rate of steel companies having 94 per cent of the steel capacity of the industry will be 97.5 per cent of capacity

for the week beginning March 15, 1948, equivalent to 1,757,400 tons of steel ingots and castings, compared to 1,741,200 tons one week ago.

March 16

▲ In statements issued by the Administration on the subject of steel prices and inflation, it was found that the steel companies did not make a general increase in steel prices and that the amount of the increase was a small fraction of total sales.

March 17

▲ Admiral Ben Moreell, in his annual report for the Jones & Laughlin Steel Corporation, pointed out that the total cost of all J & L properties and equipment at the end of 1947 amounted to $353,643,000 which is equivalent to $75 per ton of its annual steel making capacity. Replacement of these properties today would cost between $200 and $300 per ton of annual capacity.

March 18

▲ Although a great deal of publicity has been given to price increases in the steel industry, it is not as well known that aluminum producers have also been quietly raising their base prices and readjusting their extras during the past few months.

▲ The Federal government estimates that in 1948, 6 to 8 million tons of finished steel products will be required for construction alone.

▲ The Commerce Department figures show that iron and steel exports for 1947 totaled 6,591,282 net tons or almost 2,000,000 tons more than 1946. Approximately 4,200,000 tons of this were shipped directly by steel companies.

March 19

▲ The Allis-Chalmers Manufacturing Company reported that net profits for 1947 were $1.69 per share after preferred dividend requirements and federal income taxes. Net sales in 1947 were $211,949,890, compared with $93,840,030 for 1946.

▲ Stocks today showed the widest gain since July last year.

March 20

▲ A survey made by the Koppers Company, Inc., as to what employees want most from their company, determined that job stability is their priority requirement.

March 21

▲ The Jones & Laughlin Steel Corporation announced that they have purchased the entire capital stock of Darr Smokeless Coal Company, which operates a mine at Twin Branch, West Virginia. The coal is estimated at 10,000,000 tons, and the mine has been producing 700 to 800 tons per day. J & L expects to produce 1700 tons per day after full mechanization is completed.

March 22

▲ The Office of International Trade, Department of Commerce, set up quotas for 48 principal importing countries. The distribution of these quotas has been based on the stated needs of these countries.

▲ The current walkout of the bituminous coal miners is the sixth major interruption of coal production since the end of the war.

▲ The operating rate of steel companies having 94 per cent of the steel capacity of the industry will be 95.7 per cent of capacity for the week beginning March 22, 1948, equivalent to 1,725,000 tons of steel ingots and castings, compared to 1,757,400 tons one week ago.

March 24

▲ In the annual report of the United States Steel Corporation, it is stated that dollar receipts from customers in 1947 were the highest of any previous year and amounted to $2,122,800,000. This income is equivalent to a profit of six cents per dollar of sales, was equal to 7.4 per cent on investment, and equivalent to $11.70 per common share.

March 25

▲ Canadian aluminum industry is now expected to operate at full capacity throughout 1948. In 1947, the Canadian industry produced approximately 606,000,000 pounds of aluminum, compared with 1,142,000,000 pounds in the United States.

March 26

▲ The National Steel Corporation announced that in spite of the fact that total sales of $328,957,189 in 1947 were the highest in the history of the company, the ratio of earnings to sales dropped. Net earnings for the year were $26,838,788 or $12.03 per share, compared with $9.17 per share the previous year.

March 27

▲ The United States Steel Corporation announced that the earliest spring operations in the history of the company were undertaken when two of its fleet of freighters started Great Lakes trips. The Coast Guard ice-breaker Mackinaw has opened the straits of Mackinac. Ice in the straits was not as heavy as in previous years at the same time.

▲ Cleveland Cliffs Iron Company announced its 1948 season prices on iron ore. These prices will be based on $6.20 a gross ton delivered at lower lake ports for Mesabi Range non-bessemer ore, 51.50 per cent iron natural content. These prices are 65 cents per gross ton higher than the 1947 season quotations.

March 28

▲ S. A. Swensrud, vice president of Gulf Oil Corporation, stated that although the Western Hemisphere at the present time has a surplus of oil production, it is estimated that by 1951-52 the Western Hemisphere must import about half a million barrels a day from the Eastern Hemisphere. Most of these imports would come from the Middle East.

March 29

▲ It is estimated that the country's expanding program of military preparation may possibly increase chances for the adoption of government economic control.

▲ Stocks of iron ore on hand at furnaces in Lake Erie docks are at the lowest level in history and total only slightly over 15,000,000 tons.

March 30

▲ The effect of the coal strike is beginning to be seen in steelmaking operations which are now beginning to decline. The operating rate of steel companies having 94 per cent of the steel capacity of the industry will be 89.4 per cent of capacity for the week beginning March 29, 1948, equivalent to 1,611,400 tons of steel ingots and castings, compared to 1,725,000 tons one week ago.

March 31

▲ Bituminous Coal Research, Inc., announced that the bituminous coal industry launched a $250,000 engineering program to design a machine that will mine coal cheaper and faster.

▲ The Acid Open Hearth Research Association announces the total tonnage of acid open hearth steel melted for 1947 for both castings and ingots was 1,257,673 tons, compared with 1,132,199 tons in 1946.

▲ Admiral Ben Moreell, president of Jones & Laughlin Steel Corporation stated that steelmaking costs other than wages have risen $3 a ton since October 1, 1947.

- Continuous atmospheric control
- Precision heat regulation
- Low gas consumption

Swindell Bottom Entry Malleable Furnaces, with specialized design and construction features, provide outstandingly efficient performance in malleable castings production. *May we have your inquiry?*

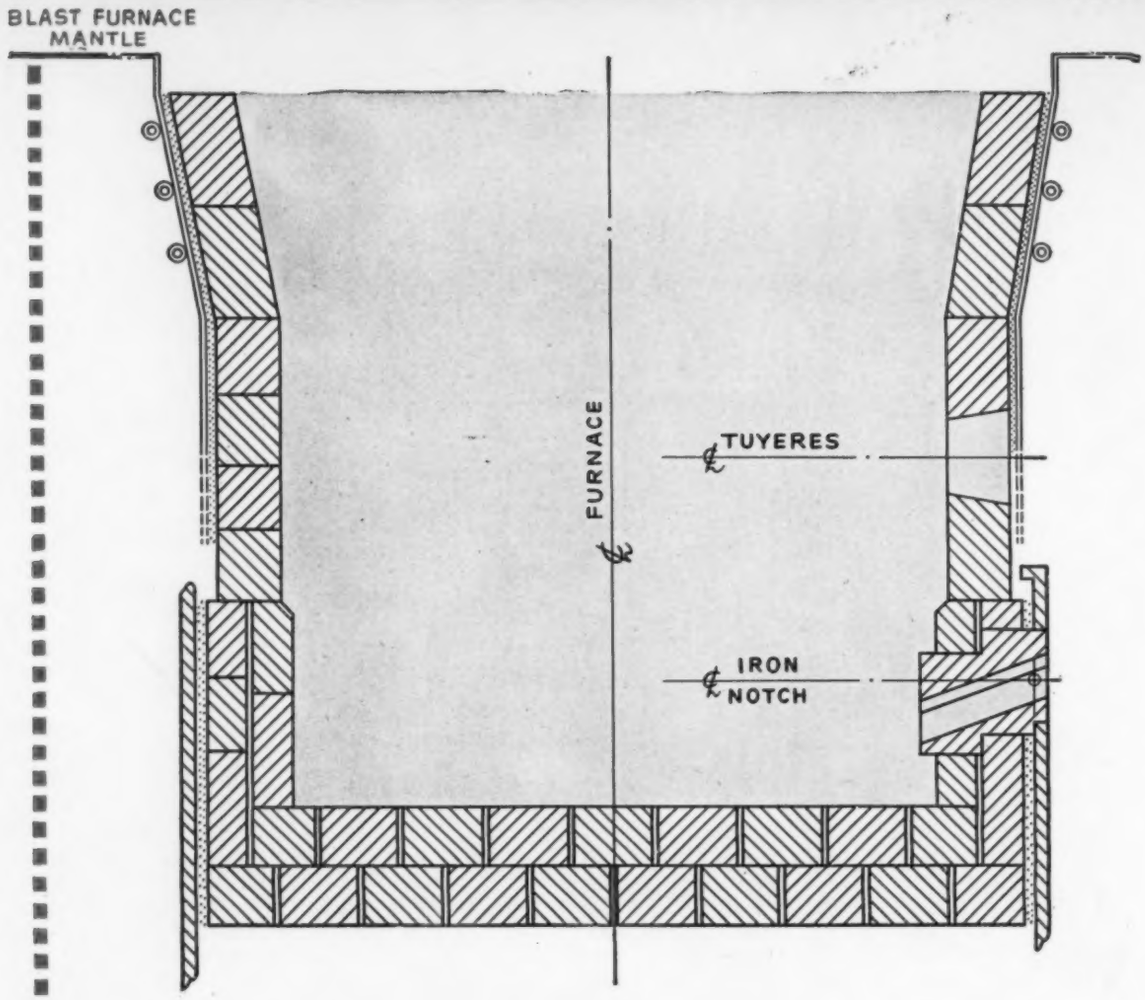
SWINDELL

Bottom Entry MALLEABLE FURNACES

SWINDELL-DRESSLER *Corporation*

DESIGNERS AND BUILDERS OF MODERN INDUSTRIAL FURNACES

PITTSBURGH, PA.



Line it up to the mantle... with "National" Carbon

"National" carbon blocks have become the standard material for blast-furnace linings, for iron notches and cinder notches. And now, for real economy and efficiency, the trend in design takes the carbon-block lining up to the mantle.

Here are the reasons:

1. "National" carbon blocks last indefinitely. They have no melting point... are highly resistant to slag attack and thermal shock... are not wet by molten metal... have low thermal expansion... and maintain their mechanical strength at high temperatures.

2. "National" carbon blocks are easy to install. One carbon block takes the place of from 50 to 1000 nine-inch firebrick, depending on the size of the block. This means fewer joints, sounder joints, faster installation, and lower cost.

For more information on the use of "National" carbon blocks in blast furnaces, write to National Carbon Company, Inc., Dept. IS.

These products sold in Canada by Canadian National Carbon Company Limited

The term "National" is a registered trade-mark of

NATIONAL CARBON COMPANY, INC.

Unit of Union Carbide and Carbon Corporation

UCC

30 East 42nd Street, New York 17, N.Y.

Division Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

STEEL SCRAP IS URGENTLY NEEDED. BE SURE TO TURN YOURS IN!

Personnel News . . . .

G. E. Stoltz has been appointed consulting metal working engineer of the industry engineering department and **W. R. Harris** the manager of the metal working section, industry engineering department, Westinghouse Electric Corporation, East Pittsburgh, Pennsylvania.

Mr. Stoltz was graduated from Ohio State University in 1909 and entered the employ of the corporation the same year. He has been continuously identified with steel mill activities since that time — first as an engineer and later as a supervisor. He has been manager of the metal working section since 1938 and it is from that assignment he assumes his new duties.

Mr. Harris was graduated from West Virginia University in 1937 and received his master's degree from the University of Pittsburgh in 1941. He joined Westinghouse in 1937 as a graduate student and entered the industry engineering department in 1938 during which time he has had numerous industry assignments.

David C. Affleck was promoted to assistant chief engineer of the Gary steel works, of Carnegie-Illinois Steel Corporation. Mr. Affleck previously had been general supervisor of project engineering. He has been associated with United States Steel corporation subsidiaries for the last 24 years. He started as a draftsman and advanced through various drafting and engineering positions. He is a graduate of Valparaiso University.

Thomas W. Hunter was appointed tin mill division superintendent of Carnegie-Illinois Steel Corporation's Gary sheet and tin mill. Mr. Hunter is a native of Reynoldsville, Pennsylvania. He is a graduate of Carnegie Tech with a mechanical engineering degree. He has been associated with Carnegie-Illinois for the last 12 years. His previous experience was largely in the Pittsburgh district until he transferred to the Gary plant four years ago.

W. Guy Hoffman was promoted to flat rolled products engineer of Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania. Mr. Hoffman is a native of Oil City, Pennsylvania. He attended Carnegie Tech. He has been associated with Carnegie-Illinois since 1901. He was made chief engineer of Gary sheet and tin mill in 1936 and was appointed division superintendent of the tin mill in 1939.

C. E. Bayer was appointed assistant vice president of operations for Great Lakes Steel Corporation, Ecorse, Michigan. Mr. Bayer was formerly general superintendent of Weirton Steel Company, Weirton, West Virginia. These companies are divisions of National Steel Corporation.

George Morlock, general foreman of Kaiser Steel's by-products, benzol and tar plant at Fontana, California, has been promoted to superintendent of the company-operated coke plant at Sunnyside, Utah.

Having joined the Kaiser Company in 1942, Mr. Morlock has served as general oven and heating foreman, and assistant to the superintendent of the by-products coke plant.

T. A. Kay, formerly assistant plant engineer, was appointed plant engineer of Fontana steel plant of the iron and steel division, Kaiser Company, Inc., Fontana, California. Mr. Kay replaces **W. A. Vogt** who was transferred to Kaiser Engineers, Inc., Oakland, California.

Dr. John A. Hutcheson has been appointed director of the Westinghouse Research Laboratories, succeeding **Dr. L. Warrington Chubb.** Dr. Chubb, who is retiring from active direction of the laboratories for reasons of health, has been named director emeritus and will continue to serve in an advisory capacity. The veteran scientist recently rounded out 40 years of research and engineering with Westinghouse, the last 17 as head of the laboratories.

Dr. Hutcheson assumes his new post after four years as associate director of the laboratories. During this period he directed the company's extensive wartime radar research program and later the formulation of plans for atomic energy development. He will remain active in both fields.

L. H. Gillette has been appointed manager, heating section sales, transportation and generator division, Westinghouse Electric Corporation, Meadville, Pennsylvania. Mr. Gillette was graduated from the University of Idaho with a bachelor of science degree in electrical engineering. He entered the Westinghouse graduate student training course in 1939. Upon completion of this course in 1940, he was assigned to the heating section sales department where he has remained until his appointment as manager.

G. E. STOLTZ

W. R. HARRIS

DAVID C. AFFLECK

THOMAS W. HUNTER

J. J. BOOTH

K. L. JOHANNSEN

R. H. CURRIE

F. J. NUTTALL

J. J. Booth, formerly superintendent of maintenance department, has been named division superintendent, maintenance, in a recent reorganization of the maintenance division at Carnegie-Illinois Steel Corporation, Duquesne works, Duquesne, Pennsylvania. The following other changes in occupational duties and titles were made:

K. L. Johannsen, formerly superintendent of maintenance, is now superintendent, assigned and operating maintenance.

Raymond H. Currie, formerly assistant superintendent, maintenance, becomes superintendent, shops, maintenance division.

Francis J. Nuttall, formerly superintendent, fuel and steam power, was appointed superintendent, utilities.

James J. Roderick, formerly general foreman, bar mill maintenance, was made assistant superintendent, assigned and operating maintenance.

John H. Hite, assistant to superintendent, maintenance division, becomes assistant superintendent, shops, maintenance division.

Charles H. Good, Jr., assistant superintendent, fuel and steam power, was named assistant superintendent, utilities.

A. E. Maha was appointed assistant sales manager for the central division of the ball and roller bearing division of Link-Belt Company. Mr. Maha joined the Link-Belt ball and roller bearing division engineering department, Indianapolis, in 1938 and was subsequently appointed district sales engineer in Chicago territory. He was later transferred back to Indianapolis to look after home office sales. Mr. Maha attended Purdue University and was graduated with a bachelor of science degree in mechanical engineering in 1934. He entered the employ of another bearing manufacturer and was their chief engineer at time of joining the Link-Belt organization.

Lewis M. Watkin, Jr., was named assistant sales manager, in charge of the eastern division, of the ball and roller bearing division of Link-Belt Company. Mr. Watkin joined the Link-Belt organization in 1945, and after working in various departments of the Dodge plant, including engineering, he was transferred to Philadelphia in the capacity of district sales engineer. His prior experience in the application of ball and roller bearings extended over a period of 31 years, in which time he served various well-known ball and roller bearing manufacturers in an engineering and/or management capacity. Mr. Watkin attended Drexel Institute of Technology, receiving his bachelor of science degree in mechanical engineering in 1912. His headquarters will be in Philadelphia, Pennsylvania.

R. R. Tatnall has been appointed to the position of field service metallurgist in charge of customer relations for Colorado Fuel and Iron Corporation, Wickwire Spencer Steel division.

H. H. Angel has been transferred to the construction engineering department of Bethlehem Steel Company at Bethlehem, Pennsylvania. Mr. Angel was formerly assistant to electrical superintendent at Bethlehem Steel Company's Sparrows Point, Maryland, plant.

Willard K. Fohl has been named manager of service for Lukens Steel Company and its divisions, By-Products Steel Company and Lukenweld, Coatesville, Pennsylvania.

Mr. Fohl has been associated with Lukens Steel Company since 1937, serving in the research and open hearth departments until 1939 when he was named assistant research metallurgist. He served in that capacity except for 2½ years active duty in the Pacific Theatre of War, as an officer with the U. S. Navy, until November 1945. In November 1946, Mr. Fohl was named manager of railroad sales. In conjunction with his duties as manager of service, Mr. Fohl will continue with his duties as manager, railroad sales.

Glenn E. Johnston has joined Lukens Steel Company, Coatesville, Pennsylvania, as a member of its sales development staff.

James Wilson has retired as manager of the field engineering section of the Allis-Chalmers steam turbine department after 43 years of service.

G. E. Hunt Atlanta district sales manager for Cutler-Hammer, Inc. has announced that their new district office location is at 714 Spring Street, NW, Atlanta, Georgia.

William B. Todd was elected executive vice president and a director of Continental Foundry and Machine Company.

In 1937 Mr. Todd left Jones and Laughlin Steel Corporation, where he had served as vice president in charge of sales, to join the steel export association of America with headquarters in London. At the beginning of the war he returned to this country and remained with that organization in New York until 1943 when he again went to London as foreign representative for the steel division of the War Production Board. In 1945 he returned to Washington, D. C., and served as director

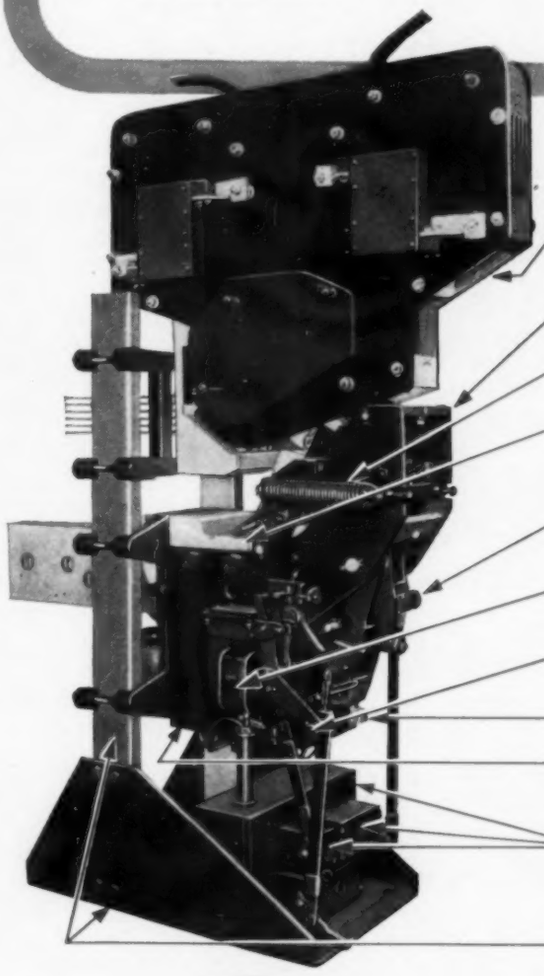
PROTECT VITAL PRODUCTION EQUIPMENT WITH THIS *Better designed-Better built* BREAKER

Short circuits and the extremely heavy overcurrents encountered in electrical distribution systems of Rolling Mills and Electrolytic plants can ruin essential generators, motors, rectifiers, and related equipment. This, and the resultant production shutdowns, and repair or replacement bills, cut deep into operating profits. I-T-E—specialists in quality Switchgear—give you *more effective, more dependable* protection from electrical disturbances with the better engineered Type MT Circuit Breaker.

Especially developed for interrupting extremely heavy direct-currents, the MT breaks a circuit in .028 seconds, (about 1¾ cycles on a 60 cycle basis) at 25% to 100% of interrupting capacity. Short circuits and overcurrents are cleared instantly, dependably. The MT is a single pole, electrically operated, D-C breaker designed for 250 and 750 volt service. Interrupting rating is 150,000 Amp. for 2000 and 4000 amperes continuous ratings, and 250,000 Amp. for models continuously rated 6000, 8000, 10,000 and 12,000 amperes. Further information on the MT is contained in catalog 2201. Send for it today.

The I-T-E representative in your locality will be glad to advise you on applying the MT—and other I-T-E protective equipment—to your electrical distribution system. Use his services without obligation.

NOTE THESE RUGGED, EFFECTIVE CONSTRUCTION FEATURES OF THE MT



MAGNETIC ARC CHUTE of large thermal capacity drives gas and arc upward for safe extinction. Arcing time is extremely short with either light or heavy currents.

SELF-ENERGIZING BUFFER MECHANISM smoothly absorbs shocks of opening—prevents sticking or bouncing.

HEAVY-DUTY OPENING SPRINGS are mechanically loaded while breaker is closed. Trip devices act directly on holding toggle for instantaneous opening.

LOWER STATIONARY MAIN CONTACT BLOCK—Main contacts are silver base inserts backed with solid blocks of copper. Silver base inserts assure contacts free from oxidation and overheating.

SIMPLE MECHANICAL SYSTEM includes a light-loaded roller-bearing latch for low friction and fast tripping.

SHUNT TRIP COIL allows remote electrical opening—by hand, by a relay, or by auxiliary switch on another breaker.

HAND TRIP BUTTON is provided to allow normal opening of the circuit at the breaker.

OPERATION COUNTER mounted on each breaker as a standard device.

CLOSING SOLENOID HOUSING—Metal enclosure protects the closing coil against corrosive mill atmosphere.

ACCESSORY DEVICES—Terminal box for control wiring, and multi-contact auxiliary switches for shunt trip coil and signal lamps, are conveniently located near base of breaker with ample space for control wiring.

SUPPORTING POST AND FABRICATED STEEL BASE—Entire frame of hot-rolled steel, formed and welded into a rugged, protective support unit.

I-T-E

MILL TYPE SWITCHGEAR

The Leader In Technical Excellence

I-T-E CIRCUIT BREAKER CO., 19th & HAMILTON STS., PHILADELPHIA 30, PA.—31 OFFICES IN UNITED STATES AND CANADA

SWITCHGEAR • UNIT SUBSTATIONS • ISOLATED PHASE BUS STRUCTURES • AUTOMATIC RECLOSING CIRCUIT BREAKERS • HIGH SPEED CIRCUIT BREAKERS

Wide Double Contact Surfaces — Spring Tension Locking of Links

KNIFE-BLADE
250 VOLTS
600 VOLTS
70 to 600 AMPS.

WARE HI-LAG Fuses provide extra wide contact surfaces on both sides of links and stronger connections. Link connections are held firm and tight at all times by large arched spring steel washers and heavy studded bolt, which locks the links into the circuit.

Expansion and contraction of metals during *Off* and *On* periods compress links. This fluctuation causes loose contacts and oxidization in other fuses, which finally result in excessive heating and unnecessary blows. WARE HI-LAG construction keeps contacts permanently tight, thus insuring low resistance and longer fuse life.

WARE HI-LAG has many exclusive features in addition to the above; including the Link Design-Double Bridge Knife-Blade Assembly-Gas Vents and Simplified Construction, only 3 Parts. That is why it is known as the World's Best and Coolest Operating Fuse made.

We manufacture all of our own parts and are making prompt deliveries.

FERRULE
250 VOLTS
600 VOLTS
3 to 60 AMPS.

APPROVED BY UNDERWRITERS' LABORATORIES

Write for Fuse Booklet No. 4460 giving all features, sizes and details.

WARE Brothers 4450 W. LAKE ST. · CHICAGO 24, ILL.

of the steel division of WPB until that agency was dissolved. He then joined Aetna Standard Engineering Company as assistant to the president, and is resigning that position to assume his new duties with Continental. His headquarters will be in Pittsburgh.

Bert E. Brashares was appointed sales engineer in the steel castings department of Continental Foundry and Machine Company. Formerly connected with the Ohio Steel Foundry Company and Commercial Steel Castings Company, Mr. Brashares was most recently associated with the Otis casting division of Jones and Laughlin Steel Corporation in Cleveland. He will be located in Pittsburgh and service the middle Atlantic states.

George C. McMullen, who has been with the Tyson

GEORGE C. McMULLEN

Bearing Corporation, Massillon, Ohio, for sixteen years, was appointed vice president in charge of sales.

W. H. Oexle joins Tyson Bearing Corporation in the capacity of general sales manager. During the past twelve years he has been with the L. S. Starrett Company of Athol, Massachusetts, in various executive sales and merchandising capacities, his last assignment being as southeastern district manager.

Frederick H. Norton was appointed vice president in charge of all sales for the American Car and Foundry Company.

William H. Schuster has been appointed welding supervisor for American Car and Foundry Company. Mr. Schuster has had a wide and varied experience as a welding engineer. He was first employed by Spang Chalfant and Company as welder from 1931 to 1935 and the following year with the Bath Iron Works in the same capacity. He then went to Lincoln Electric Company as welding instructor and from 1937 to 1940 was sales engineer for that company. From 1940 to 1946 he was general welding supervisor for Cramp Shipbuilding Company. Prior to coming to ACF he was with Foster Wheeler Corporation as welding engineer.

J. E. Sawtelle was named manager of the export

Insulated Aluminum Wire & Cable

A WIDE RANGE OF MECHANICAL CONNECTORS AVAILABLE

Use standard tools, and standard methods, to make mechanical joints in aluminum wire. With the wide range of connectors available, mechanical joints present no problems.

BOLTED-TYPE connectors: Made in both aluminum and coated copper, designed to confine the conductor closely and exert even pressure throughout the contact area.

COMPRESSION-TYPE connectors are also available in a wide range, have the advantage of high pressure between conducting surfaces.

Application of a joint compound is recommended to maintain the high efficiency of connectors.

Wire and cable with Alcoa E.C.* Aluminum Conductor is light, too—easy to handle and pull, easy to install. They're all reasons why your over-all job costs are lower when you *figure it in aluminum!*

Alcoa supplies E.C. Aluminum to leading wire and cable manufacturers who draw, strand, insulate and sell it under their own trade marks. Your wire supplier can furnish it.

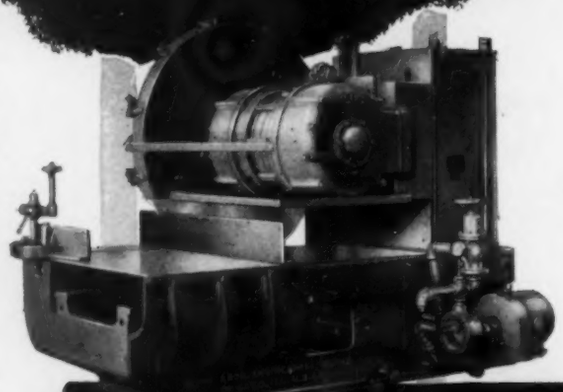
ALUMINUM COMPANY OF AMERICA, 2128 Gulf Building, Pittsburgh 19, Pennsylvania.

*E.C.; *Electrical Conductor* Aluminum

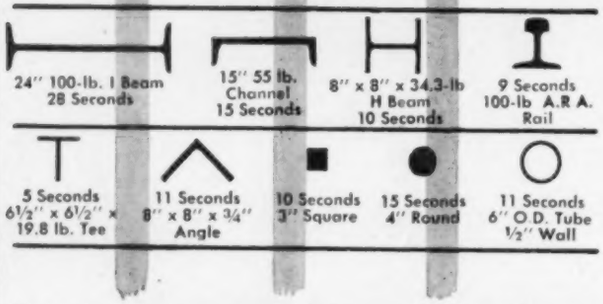
ALCOA EC ALUMINUM

FOR ELECTRIC WIRE AND CABLE

Modern Sawing



with KLING HIGH SPEED FRICTION SAWS



Friction sawing is one of few mechanical processes which employ the heat of friction in a useful manner. It concentrates heat on the material to be severed at a rate which is faster than it can absorb heat. The immediate temperature rise of the contact surface is so great that its strength is reduced considerably lower than that of the colder blade rim. This heated surface is readily removed by the blade and permits complete severing of the material rapidly with no loss of metal from the blade.

Because of its versatile ability to cut many varied structural shapes, as well as solid or hollow bars in any sequence, without change of blade or set-up, one machine can handle a volume of cutting that would otherwise require several separate shears or slow speed saws.

Consult Kling engineers regarding your metal cutting problems. State size of material to be cut. Bulletin No. 9200 giving full particulars and suggestions as to the type and size of saw will be mailed promptly. No obligation.

KLING BROS. *Engineering Works*

Punches; Bar, Angle and Rotary Shears; Combination Shear, Punch and Copers; Plate and Angle Bending Rolls; Heavy Duty Grinders

1324 N. KOSTNER AVENUE, CHICAGO 51, ILLINOIS, U. S. A.

division of the Hinderliter tool company division of the H. K. Porter Company, Inc. Mr. Sawtelle, will be located at the offices of the H. K. Porter Company, Inc., 50 Church Street, New York, New York.

O. B. Wilson has been named industrial manager for the eastern sales region of the Brown Instrument division of Minneapolis-Honeywell Regulator Company.

Mr. Wilson's promotion will make him regional manager of the territory extending from Northern Virginia, through eastern Pennsylvania, to the Canadian border, west to Rochester, New York, and in New England.

He has been with the Honeywell-Brown organization for the past 25 years. He has served as a sales engineer in various parts of the country and has been industrial manager in Houston, Chicago and New York. He will continue to make his headquarters in New York City where he has been the Brown manager for the past two years.

W. E. Quillian has been appointed chief estimator and purchasing agent of the Salem Engineering Company's southwest branch at Fort Worth, Texas. Until his recent appointment to the southwest branch, Mr. Quillian served as chief estimater in the company's main office.

Rush F. Young was appointed as manager of the Pittsburgh sales district for Pennsylvania Transformer Company. Mr. Young's offices will be located at the company's headquarters, 808 Ridge Avenue, Pittsburgh, Pennsylvania. Mr. Young came to the transformer company in 1945 to take charge of the distribution transformer section of the sales department. For nine years prior to that, Mr. Young was associated with the

RUSH F. YOUNG

Westinghouse Electric Corporation at the magnetic laboratories of the East Pittsburgh works and in the production, manufacturing and sales departments of the Sharon transformer division. Mr. Young, a native Pittsburgher, graduated from Rutherford College, North Carolina, and continued his science studies at Carnegie Institute of Technology. Mr. Young will be in charge of the distribution and power sales in Western Pennsylvania.

E. S. Banghart has been named as manager of the New York district for Pennsylvania Transformer Com-

new facilities

faster, more complete service

Continental ROLLS

An entirely new, complete roll turning shop has been added at Warwood Plant (Wheeling, W. Va.) to assure faster delivery to you of a greater volume of the vital iron and steel rolls you need in any degree of finish specified. Look to CONTINENTAL for faster, better roll service.

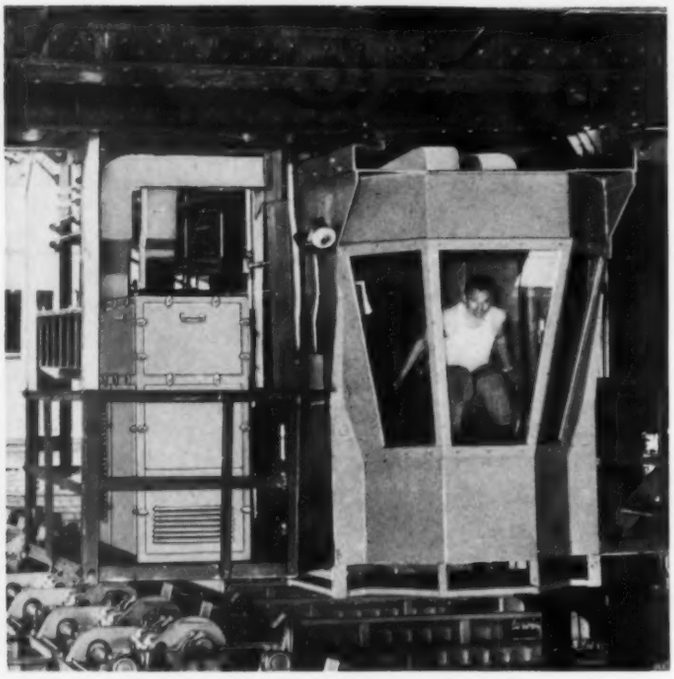
Continental

Continental

FOUNDRY & MACHINE CO.

CHICAGO · PITTSBURGH

PLANTS AT: E. CHICAGO, IND.; WHEELING, W. VA.; PITTSBURGH, PA.



Soaking Pit Crane in Plant of a prominent steel company, equipped with Lintern Aire-Rectifier 145 AC-24.

The Only Crane Cab Conditioner Thoroughly Tested on Soaking Pit Applications

● In the illustration above the Lintern Aire-Rectifier was tested on the particular crane shown. It is the center crane of three.

After thorough testing, the plant installed Lintern Aire-Rectifiers on the other two cranes. All three gave satisfactory performance thoughout the past hot summer.

Lintern balanced refrigeration design prevents overloads in temperature as high as 170° F. This is the only crane cab conditioner which has had thorough testing on soaking pit applications. It is tried and proved. Only periodic inspection is required.

Ask for Bulletin AC 82147 describing the four new models now available for all types of mill and industrial cranes.

THE LINTERN CORPORATION
54 LINCOLN AVENUE - - BEREA, OHIO

Glowlite Signals, Lanterns, Sanders, Shock Absorbers for Lamps, Ventilating Heaters, Aire-Rectifiers for Overhead Cranes

pany. Mr. Banghart was associated with the Allis-Chalmers Manufacturing Company for 20 years in their New York and Washington offices. Previously, from 1923 to 1927, Mr. Banghart was New York manager of the Pittsburgh Transformer Company.

E. S. BANGHART

Prior to that, he was associated with the United Electric Light and Power Company of New York and the New York Edison Company. Mr. Banghart is an alumnus of Cornell University. Pennsylvania Transformer Company's New York district office is located at 25 Broad Street, New York, New York.

Jan M. Krol, consultant in foundry practice and development engineer in hot-pressing and vacuum techniques for the cemented carbide field, and **Robert Lane Pettibone,** specialist in the heat treatment of powder metal parts, announce their affiliations with Sintercast Corporation of America, New York, as chief metallurgical engineer and research metallurgist, respectively. Both will work under **Dr. Claus G. Goetzel,** vice president and director of research of Sintercast, research and development organization in powder metallurgy.

Mr. Krol received his training as Dipl. Ing. at the University of Warsaw, Poland. He is known both as the author of texts on foundry practice and as the works manager at Hard Alloys, Ltd., in England where he devoted most of his time to the development of the hot pressing technique and armor-piercing core production. As consultant for many European concerns (Sweden—A. B. Bofors; France—Les Decolletages de Commentry), Krol became known for his work on tungsten carbides, precision casting, and hot-pressing and vacuum techniques for producing high-temperature powder metal parts. He will pursue similar studies at Sintercast.

Mr. Pettibone has studied engineering and metallurgy at University of Virginia, Newark College of Engineering, Brooklyn Polytechnic, and Columbia. During service at Curtis Wright, at Springfield Heat Treating Corporation, at Precision Metal Products Company, and in his own consulting firm, Lane Engineering, he has specialized in the heat treating methods. His best known work is in connection with brazing processes and with the improvement of properties of powder metal

HOW'S THIS FOR

Speed IN

BLAST FURNACE CONSTRUCTION ?

in 70 days

The William B. Pollock Company Dismantled and Rebuilt a Blast Furnace

The Jackson Iron and Steel Company gained almost three months of pig iron production by employing The William B. Pollock Company to replace their blast furnace. The old one was dismantled and iron was cast from the new one on the 70th day . . . normally a 150 day job.

Seven days after blowing out, the old blast furnace was being removed in gigantic sections. Nine days later the base plates for the new furnace were put in place. Twenty-eight days after blowing out, the top of the new furnace was in place, and three days later the top platform was being erected. On the 70th day, the new blast furnace was completely finished and put into operation.

This was another example of Pollock's experience, speed, and resourcefulness to accomplish outstanding construction records. The Pollock Company can do the unusual for you too. Consult our engineers about blast furnaces or other heavy construction.

1. On the seventh day, the furnace stack was cut into eight pieces and lowered to the ground.

2. On the twenty-eighth day, four uptake connections were in place. The furnace was now ready for the top ring and platform.

3. On the sixty-fifth day. Construction was practically finished and preparations for the blow-in were being made.

POLLOCK

THE WILLIAM B. POLLOCK COMPANY
YOUNGSTOWN · OHIO

STEEL PLATE CONSTRUCTION · ENGINEERS · FABRICATORS · ERECTORS

BLAST FURNACES · HOT METAL CARS AND LADLES · CINDER AND SLAG CARS · INGOT MOULD CARS · CHARGING BOX CARS · WELDED OPEN HEARTH LADLES

parts through heat treatment. He has been one of the more active researchers in the field of the copper-infiltrated-steels, and closely associated with Dr. Goetzel since February, 1945. His studies for Sintercast Corporation of America will embrace the investigation of many new combinations of metals and metallic compounds for parts produced by infiltration (the technique of impregnating porous skeletons of one material with molten infiltrants of other materials).

Robert Perchet, chief engineer of Societe D'Electro Chimie, D'Electro Metallurgie et des Acieries Electriques d'Ugine has spent the past month at the plant of the C. M. Kemp Manufacturing Company in Baltimore, Maryland, studying the methods and procedures of dehydration of air, gases and liquids. Upon his return to France, Mr. Perchet, as manager of Durferrit-Sofumi S. A., will manufacture desiccant drying equipment under license from the Kemp Company.

Frank Beattie was named New England district manager, for E. W. Bliss Company with headquarters at 129 Church Street, New Haven, Connecticut. **Fred Milnes,** for many years with the Aluminum Company of America, has been appointed assistant district manager of the New England district. **Fred A. Power,** sales representative in New England for the past thirty years, has retired, and the company's Boston sales office has been closed.

R. B. Ritschard has been transferred from Bailey Meter Company's Cincinnati office to its Cleveland district office. Mr. Ritschard has been with Bailey Meter Company since 1936.

Carl W. Lange and **Claude B. Huston,** who recently received the General Electric Company's highest honor, the Charles A. Coffin Foundation Award, won this recognition for developing electrical equipment benefiting the steel industry.

Mr. Lange, formerly engineer in charge of the d-c Armored motor division, Erie works, until his retire-

CARL W. LANGE

ment in 1947, was recognized for having redesigned the standardized line of heavy duty mill-type motors. These redesigned motors were demonstrated to the Association of Iron and Steel Engineers in May 1946, and were the basis for the new standard adopted in 1947 for the industry. Mr. Lange was chairman of the

COMPOSITION OF TITANIUM ALLOYS USED IN STEEL MAKING

PERCENTAGE	High Carbon FCT	Medium Carbon FCT	Low Carbon Ferro Titanium	Steel Foundry Ferro Titanium	Iron Foundry Ferro Titanium	Carbortam	Manganese Titanium	Nickel Titanium
TITANIUM	15-18	17-20	38-42	25-27	19-21	15-17	25-28	25-28
TOTAL CARBON	6-8	3-5	0-.1	0-.1	0-.05	6.5-7.5	0-.1	0-.1
GRAPHITE	3-4	0-.1						
SILICON	2-3	2-3	3-5	20-24	19-21	2.5-3.5	2-4	1-3
ALUMINUM	1-2	1-2	6-9	0.5-1	0-1	1-2	7-9	6-8
MANGANESE	0-1	0-1			0-1		35-40	
IRON	70*	70*	47*	50*	57*		20-25	2-5
SULPHUR	0-.1	0-.1			0-.1			
PHOSPHOROUS	0-.1	0-.1			0-.1			
NICKEL								60-65
BORON						.9-1.15		

*Approximate balance of composition

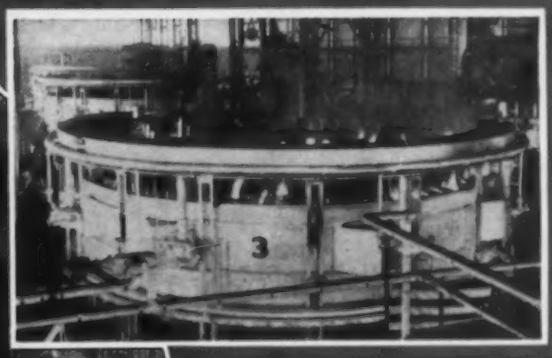
These regular Titanium Alloys are stocked to facilitate prompt shipment. Packaged to accurate weights, they help expedite use. Other special alloys are also available in 600 lb. or more lots for experimental and metallurgical use. To assist in meeting your requirements correctly, an adequate staff of chemists, metallurgists and technicians man our modern laboratories. In the field, qualified engineers welcome the opportunity to assist and cooperate with your staff.

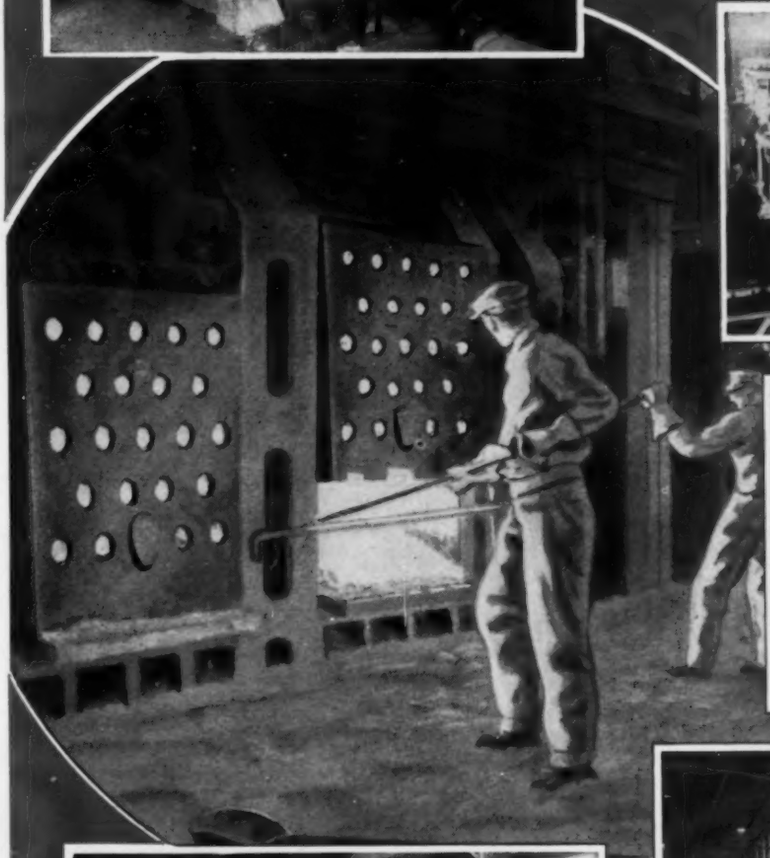
TAM

TITANIUM ALLOY MANUFACTURING COMPANY

Executive Offices: 111 Broadway, New York City General Offices and Works: Niagara Falls, N. Y.

IT'S LOFTUS *all* *Along the Line*





Loftus builds furnaces and complete plants—From Open Hearths right down the line to Heating Furnaces for the final rolling.

Inquiries invited.

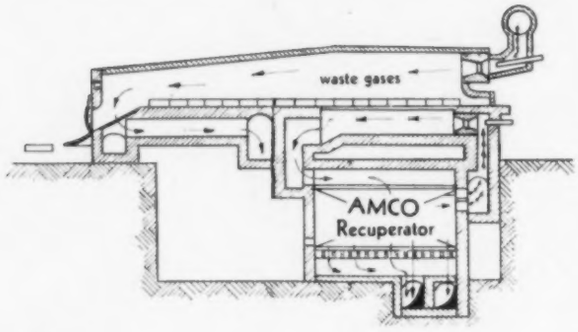
610 SMITHFIELD ST **LOFTUS ENGINEERING** *corporation* PITTSBURGH, PA.

Designers and Builders Engineers, Consultants, Contractors

Charging end firing for quality heating

AMCO

CONTINUOUS SLAB HEATING FURNACE



Ask for details

SEND FOR OUR NEW RECUPERATOR *Bulletin*

AMSLER MORTON CORPORATION

CHAMBER COMMERCE BUILDING

PITTSBURGH 19, PENNSYLVANIA

sub-committee of motor manufacturers which prepared new AISE standards for mill motors.

For designing a novel and improved type of control for reversing blooming and slabbing mills, Mr. Huston, an engineer in the industrial engineering divisions, Schenectady works, received his award. By employing amplidyne exciters in the design of the control, Mr.

CLAUDE B. HUSTON

Huston made it possible for large drives, up to 10,000 hp capacity, to be reversed from base speed forward to base speed reverse in less than 1¼ seconds. Twenty-eight equipments using this control have been installed to date and five more are now being manufactured to fill outstanding orders.

Charles J. Brown, works superintendent at American Steel and Wire Company's Rankin, Pennsylvania, works, has retired after 38 years service. Mr. Brown was born in Sherman, New York, and was educated in the public schools of that city and Cleveland, Ohio, before entering Case School of Applied Science in the latter city, where he majored in engineering and chemistry. His history with United States Steel Corporation dates back to June, 1904, when he started working for the Pittsburgh Steamship Company as an oiler on the steamer Joliet. He also worked for the Pittsburgh and Conneaut Dock Company, another U. S. Steel subsidiary, before joining American Steel and Wire Company in August, 1909, as a blower at historic Emma blast furnace. He held a variety of positions in five other wire company plants in the Pittsburgh and Cleveland districts before being appointed superintendent of the Donora wire works in January, 1928. He has held the position he now relinquishes since June, 1938.

Howard P. Meredith has been appointed works superintendent at American Steel and Wire Company's Rankin works at Rankin, Pennsylvania.

A native of Monongahela, Pennsylvania, Mr. Meredith was educated in the public schools of that city before matriculating at the Carnegie Institute of Technology, being graduated from that institution with a bachelor of science degree in works management. He first started working for American Steel and Wire in July, 1927, when he began as a special apprentice in the wire drawing department at the company's Donora steel

SUBMERGED FOR 13 YEARS AND STILL GOOD!

...isn't this the kind of splice you'd like to make?

This photograph shows one of several splices protected with Okonite and Manson Tapes after removal from test following 13 years immersion in water.

The story of this long-time test explains the confidence placed by electrical men in Okonite and Manson Tapes especially for splicing and tapping underground cables installed in wet locations — such as non-leaded rubber-insulated network cables and power feeders.

Each year all of these splices, made on 4/0 Okosheath 600-volt network cable, withstood a test at 7000 volts a-c for five minutes. Insulation resistance readings were still in excess of 370,000 megohms when the splices were removed for examination. Such prolonged immersion had not affected the electrical strength.

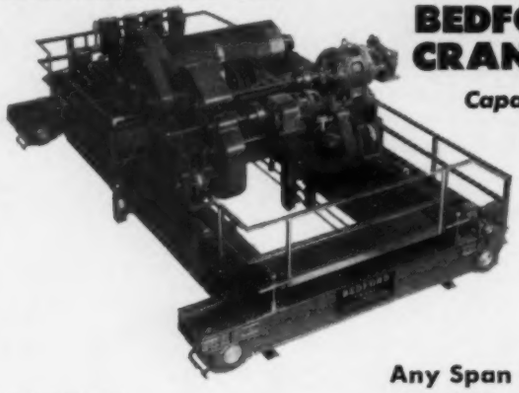
Dissection showed that the Okonite splicing compound was securely bonded to the connector and conductors and had become vulcanized into a firm, homogeneous seal that not one drop of water had penetrated. That's why so many experienced users say that for long, trouble-free service there's nothing like Okonite Rubber and Manson Friction Tape for splicing rubber-insulated cables.

We'd like to show you how easy it is to make joints like these. Just drop us a note on your company letterhead and ask for Bulletin IS-1007 *and samples* of these high-grade splicing tapes. The Okonite Company, Passaic, N. J.

SPECIFY

OKONITE SINCE 1878 **and MANSON TAPES**

CRANE BUILDERS Since 1903



BEDFORD CRANES

Capacities 5 to 150 Tons

Designed and Engineered to Meet Your Requirements

Any Span or Lift
Send For Your Copy Of Catalog

ELECTRIC OVERHEAD TRAVELING CRANES
GANTRY CRANES • STEEL DERRICKS
BUILT TO YOUR SPECIFICATIONS
STRUCTURAL STEEL • STEEL BUILDINGS

BEDFORD FOUNDRY & MACHINE CO.

Engineers
Designers
Fabricators

BEDFORD, INDIANA
U. S. A.

Gray Iron Castings

The Way to Meet the Critical Fuel Situation

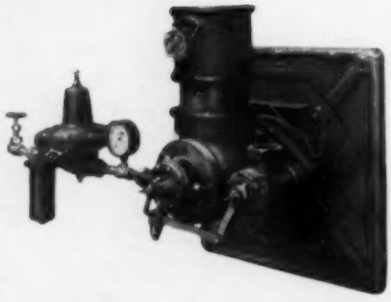
HAUCK *Combination* Oil and Gas BURNERS

ARE JUST AS EFFICIENT BURNING GAS OR OIL

Simple, easy to install and operate; just as efficient burning one fuel as the other; hundreds of these Hauck Combination Burners are proving their true value in steel mill furnaces in these critical times.

One control lever regulates and proportions the flow of air through the burner and at the same time the flow of oil or gas, or both fuels when so adjusted.

Once burners are adjusted for burning either oil or gas, the change from oil to gas or vice versa can be made quickly by merely closing one fuel shut-off valve and opening the other, without piping changes.



Combination Proportioning Oil and Gas Burner for Automatic Control
get Catalog 407S

HAUCK MANUFACTURING CO.

114-124 TENTH ST. • BROOKLYN 15, N. Y.

and wire works. In February, 1941, he was transferred to the now-abandoned Allentown works as foreman of the nail department. Two years later, he was moved back to Donora where he held a variety of positions before being named superintendent of the finishing department in August, 1945. Since September, 1946, Mr. Meredith has been assistant works superintendent at Rankin, Pennsylvania.

Wilmer H. Cordes, manager, market development division of American Steel and Wire Company, has been named to assume the added duties of manager of the advertising division of that United States Steel subsidiary. Mr. Cordes this year will celebrate his 35th anniversary with American Steel and Wire, having first been employed as a messenger in the mailing department at Chicago in August, 1913. Within three months he was transferred to the advertising department and worked his way up through the ranks, being appointed manager of advertising in December, 1928. He subsequently held a number of other positions before being named manager, market development division in January, 1947.

O. B. Stauffer, Jr., has been named assistant manager, advertising, American Steel and Wire Company, Cleveland, Ohio. Born in St. Paul, Minnesota, Mr. Stauffer is a graduate of Baldwin-Wallace College. He had seven years experience in the printing industry before joining the U. S. Army Air Corps where he spent two years. Since April, 1944, he has been supervisor, advertising production, of American Steel and Wire.

J. A. Butler has been named treasurer of Falk Corporation. Formerly assistant treasurer and comptroller, he has been associated with the company for 11 years and assistant treasurer since 1941.

R. G. Huntress has been appointed manager of wire rope sales for California Wire Cloth Corporation, a subsidiary of Colorado Fuel and Iron Corporation.

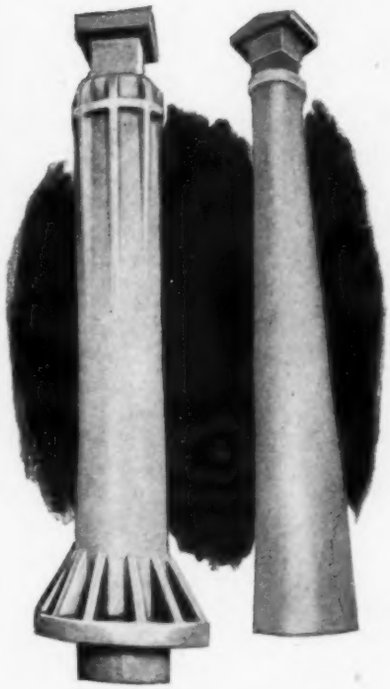
Roger W. Batchelder has been appointed assistant to the president of the National Bearing division of American Brake Shoe Company. Mr. Batchelder, formerly general purchasing agent for the company, has been with Brake Shoe since 1933. A native of North

ROGER W. BATCHELDER

Reading, Massachusetts, he attended Phillips Academy and Yale University. In his new position he will be

THE "HINGES OF HELL" ARE LUKEWARM

. . . compared to the inferno of a modern open hearth furnace.
And, considering the recent advances in both temperatures and charging speeds,
Boxes and Peels must take greater punishment than ever before.



UNION *Alloy Steel* PEELS

Except for the charge itself, no piece of unprotected metal is subjected to greater heat for a longer time than the peel. And, hot or cold, it must withstand severe shock and stresses as well. "Union" has developed for this tough service peels of heat and shock resistant alloys in designs that add months to their useful life . . . Glad to quote from your specifications on either rough or fully machined castings.

UNION *Double Life Head* CHARGING BOXES

Open hearth furnace superintendents who are out for record tonnage will recognize the evident advantages of Union Boxes. That specially designed, reinforced head means "double life" without cracking or distortion . . . All square corners have been replaced by round ones which lend themselves to better casting process . . . Union Boxes are cast from UNIVAN — a special nickel-vanadium steel that maintains its superior strength under extreme conditions of heat, cold and shock . . . Whether you operate with 20, 25, 36 or even 50 cu. ft. capacity, we welcome the opportunity to prove that you can do a faster charging job for a longer time at less cost with Union Double Life Head Boxes . . . Your requests for further details and prices will receive immediate attention.

"UNIVAN" Rust Tough Steel

UNION STEEL CASTINGS

DIVISION OF BLAW-KNOX CO., PITTSBURGH, PA.

Cinder Pots • Slag Pots • Coupling Boxes • Spindles • Gears • Bells and Hoppers • Ingot Cars • Charging Cars • Annealing Boxes and Bases

overhung loads?

DE LAVAL WORM GEARS WITH SLEEVE BEARINGS

For carrying heavy overhung loads imposed by gears, cranks, pulleys or sprockets, De Laval Worm Gear Speed Reducers can be furnished with generously proportioned sleeve bearings on the output shaft; a choice of either sleeve bearings or anti-friction bearings being available in most models. Both can be depended upon for trouble-free service.

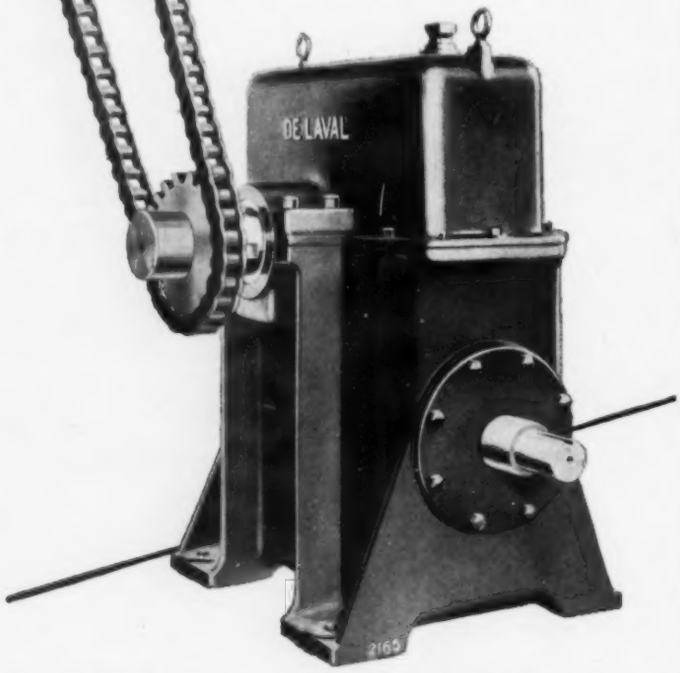


ILLUSTRATION NOTE: Use of an auxiliary chain and sprocket, with the worm gear speed reducer carrying the major reduction, allows ease of subsequent change of overall speed reduction, facilitates interchangeability of speed reducers throughout the plant, and reduces installation costs.

If your speed reducers require an overhung load, consult a De Laval representative.

ONE OF 93. This single reduction De Laval Worm Gear Speed reducer is available with many standard gear ratios and is but one of 93 sizes and types of standard De Laval Worm Gear Speed Reducers.

Worm Gear Division WG-17

DE LAVAL

De Laval Steam Turbine Co., Trenton 2, N. J.

TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS • CENTRIFUGAL PUMPS
CENTRIFUGAL BLOWERS AND COMPRESSORS • IMO OIL PUMPS

located at the division headquarters in St. Louis, Missouri.

Fred P. Biggs has been appointed first vice-president of brake shoe and castings division of the American Brake Shoe Company. Mr. Biggs has been with Brake Shoe since 1916. In addition to his new duties, he will

FRED P. BIGGS

continue as vice president in charge of sales of the brake shoe and castings and southern wheel divisions, positions which he has held since 1944. A native of St. Paul, Minnesota, he attended the University of Washington.

Joseph P. Kleinkort has been appointed general sales manager of the Ramapo Ajax division of the American Brake Shoe Company. Mr. Kleinkort, formerly eastern district sales manager, has served in various sales positions since joining the Brake Shoe company in 1923. He is a graduate of St. Louis University in St. Louis, Missouri. In his new position he will be located in American Brake Shoe's general offices in Chicago, Illinois.

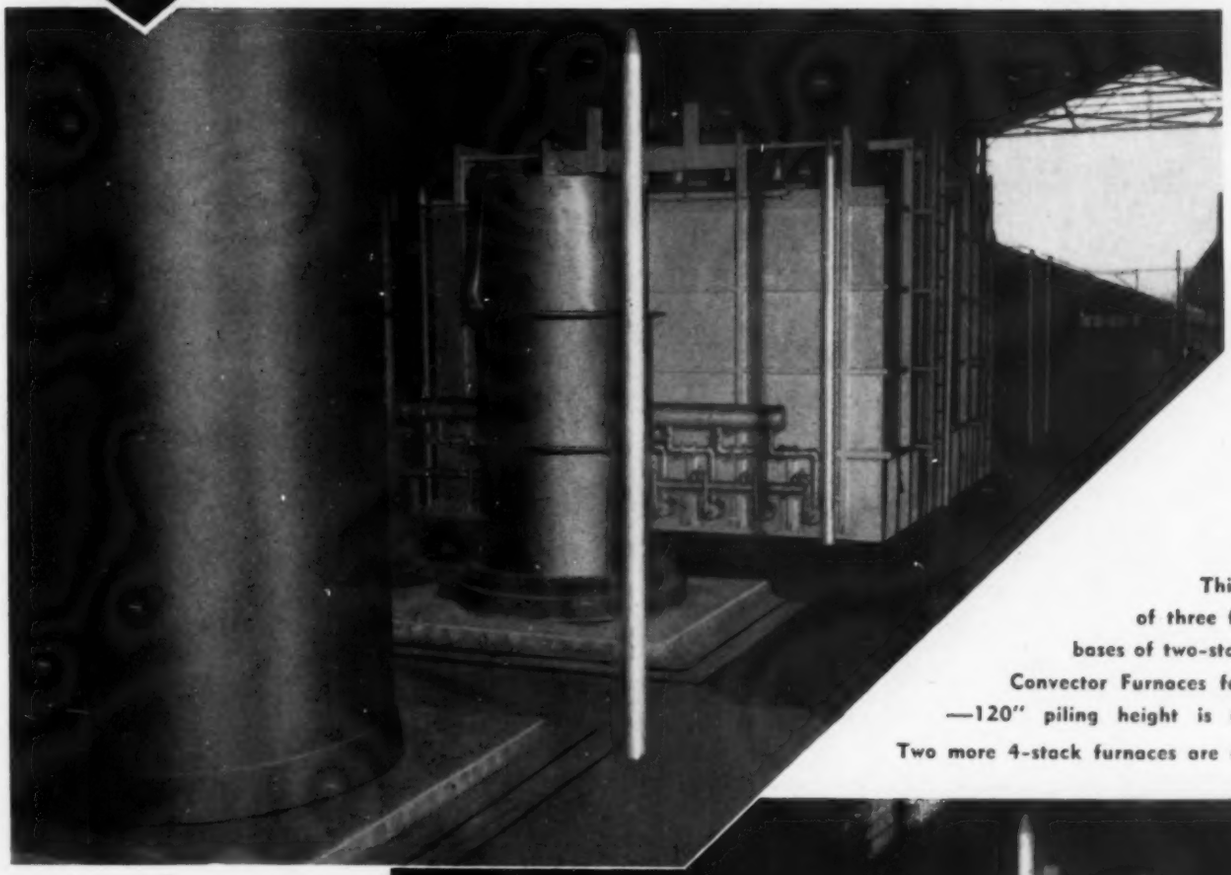
William H. Old was named general purchasing agent for American Brake Shoe Company. Mr. Old, formerly assistant general purchasing agent, has served in various purchasing capacities since he first joined the company in 1940. A native of Norfolk, Virginia, he is a graduate of Virginia Military Institute and also attended Harvard Graduate School of Business Administration. He will continue to be located in New York.

Frank B. Newbert has been appointed assistant general purchasing agent for the American Brake Shoe Company. Mr. Newbert has been with Brake Shoe since 1934 and has served in various purchasing capacities with the company. A native of Pemberton, New Jersey, he is a graduate of Rider College in Trenton, New Jersey.

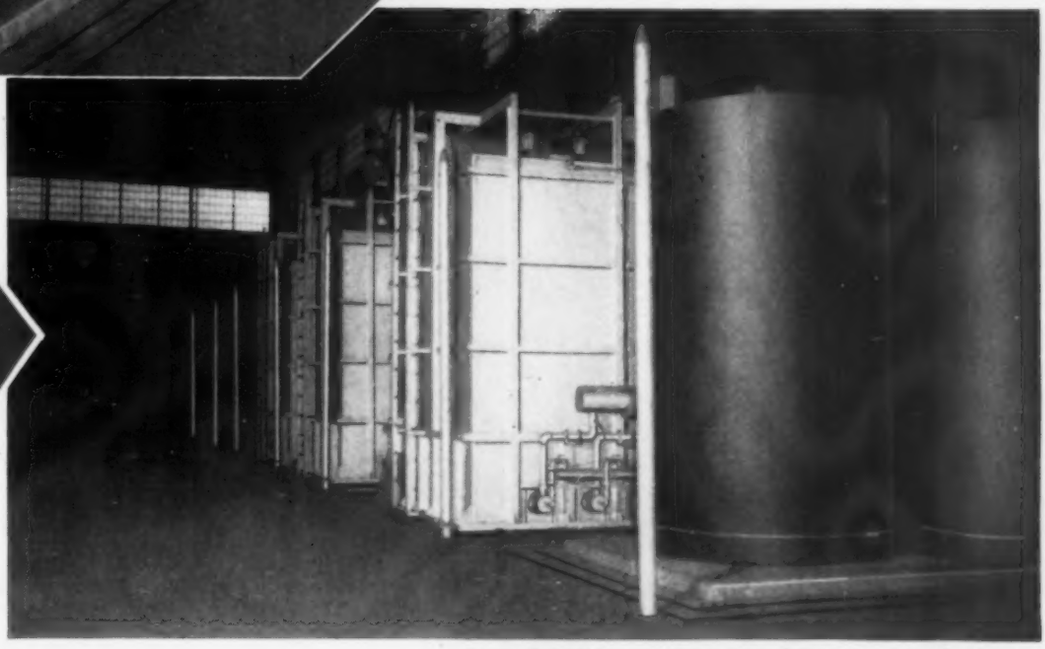
Richard L. Carroll was appointed to handle sales and service for New York and New Jersey Lubricant Company in the upper New York State area.

W. B. Coullie, vice president and a director of Harbison-Walker Refractories Company, Pittsburgh, Pennsylvania, retired March 1 in accordance with the company's retirement plan. Associated with Harbison-Walker for more than 40 years, Mr. Coullie's efforts

here ARE THE WILSON CONVECTOR FURNACES AT THE GRANITE CITY STEEL *Company*



This first installation of three furnaces and seven bases of two-stack Wilson Radiant Convector Furnaces for 60" diam. coils —120" piling height is now in operation. Two more 4-stack furnaces are under construction.



General Engineers, Mesta Machine Co., Pittsburgh, Pa.

ENGINEERED AND CONSTRUCTED BY THE

Lee Wilson

ENGINEERING Co., Inc.

20005 West Lake Road CLEVELAND, OHIO

Telephone ACademy 4670

INDUSTRIAL FURNACES ★ RADIANT TUBE HEATING ★ HEAT TREATING PROCESSES

WANTED — Experienced Sales Engineer

To represent midwestern electrical manufacturer in Pittsburgh area, including western Pennsylvania, part of Ohio, and West Virginia. Must be seasoned executive who can handle established district office. Electrical engineering graduate preferred. Practical experience in applying electric motors and controls or similar industrial lines is essential. Box 400, IRON AND STEEL ENGINEER, 1010 Empire Building, Pittsburgh 22, Pennsylvania.

L. J. Wing Mfg. Co.

154 W. 14th Street New York 11, N. Y.

Factories: Newark, N. J. and Montreal, Canada

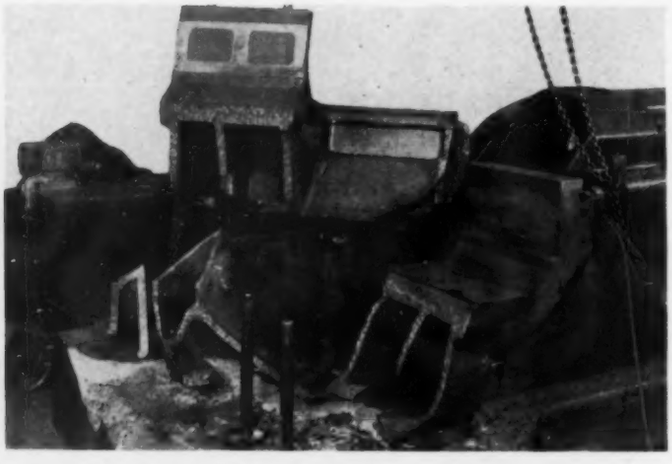
See Wing Advertisement in last issue of this publication

METALOCK

Registered Trademark

A MECHANICAL REPAIR FOR WRECKED MACHINERY

THOUSANDS SAVED BY *On location* REPAIRS WITH METALOCK



COMPRESSOR FRAME RESTORED BY METALOCK AFTER THIS ACCIDENT

APPROVED BY UNDERWRITERS

METALOCK REPAIR SERVICE

General Office: Pennsylvania Division, 530 WILLIAM PENN PLACE PITTSBURGH 19, PA.

HOME OFFICE: LONG ISLAND CITY 4, NEW YORK

were devoted almost exclusively to sales. He was appointed general sales manager in 1929 after having served as assistant general sales manager for two years. In 1937 he was elected a director of the company, and has been a vice president for the past seven years.

L. D. Litsey, formerly manager, coupling division, John Waldron Corporation, has formed the Litsey Equipment Company. This company will handle Chicago district sales for John Waldron Corporation and other companies. The new firm will be located at 6459 North Sheridan Avenue, Chicago, Illinois.

A. O. Anderson has been appointed senior field engineer of the western division for Rack Engineering Company, Pittsburgh, Pennsylvania. Mr. Anderson, who has had many years of experience in industrial engineering, was formerly production control manager of Ditto, Inc., Chicago, Illinois.

M. G. Driessen, former chief engineer of the Dutch State Mines, Holland, and inventor of the cyclone thickener and washer, is now a resident of Pittsburgh, Pennsylvania where he will serve as a consulting engineer. Heyl and Patterson, Inc., Pittsburgh, Pennsylvania, has engaged Mr. Driessen in a consulting capacity to aid in the development of better coal preparation apparatus.

Born in Hengelo (0) Holland in 1899, Mr. Driessen studied engineering at the Eidgenossich, Technisch Hochschule in Zurich, Switzerland, where he graduated

M. G. DRIESSEN

as a mechanical engineer. Continuing his studies at Delft, Holland, he earned the title of Ir.

He served his first apprenticeship with Armstrong Whitworth in New Castle, England. At the age of 24, he came to the United States to work on turbine design in the South Philadelphia works of Westinghouse Electric Corporation. After two years in the United States, he went to Switzerland to join Brown Boveri Baden as research engineer.

Four years later he returned to his native Holland to accept the position of chief of the mining research of the Dutch State Mines.

During the past 18 years at the Dutch State Mines, he invented many improvements in the art of heavy

(*Please turn to page 172*)

HERE ARE 4 WAYS THIS ROLL GRINDER does your thinking for you

Farrel roll grinders are available in two types—Type HD with traveling wheel and stationary work, and Type TT with traveling work and stationary wheel. Write for descriptive bulletins. Bulletin No. 115 describes the Type HD, Bulletin No. 113 the Type TT.

1 OIL PUMP MOTOR CONTROL is interlocked with control of grinding wheel motor, so that the latter will operate only after predetermined oil pressure has been reached, and will stop if pressure failure occurs during grinding operation.

2 REVERSAL OF CARRIAGE TRAVERSE is accomplished electrically, eliminating mechanical reversing clutches. The tripping device is located at the operator's station and when correctly set the traverse distance and the length of work are equal. Electrical control allows a slight delay at the end of the traverse for sufficient wheel contact at the roll ends before reversing.

3 AUTOMATIC CROWNING AND CONCAVING DEVICE, a built-in "brain" which guides the grinding wheel along a perfectly graduated, mathematically accurate curve. Crowned or concaved rolls are produced with both halves perfectly symmetrical. The same setting invariably produces exactly the same curvature, permitting uniform and easily controlled accuracy of contour in all rolls.

4 FLEXIBLE FACEPLATE compensates for inequalities in wabblers and automatically minimizes inaccuracies due to minor errors in setting the roll. Dead centers provide positive setting of the work.

FB-432

FARREL-BIRMINGHAM COMPANY, INC.
ANSONIA, CONN.

Plants: Ansonia and Derby, Conn., Buffalo, N. Y.
Sales Offices: Ansonia, Buffalo, New York, Boston, Pittsburgh, Akron, Chicago, Los Angeles, Tulsa, Houston.

1848 FARREL CENTENNIAL 1948

Farrel-Birmingham

Here's TORRINGTON'S 1714 Slitter...

with every feature you need for *Precision, high-speed production*

Starting with a rigid, all-welded steel base, this Torrington metal slitting machine is planned and engineered from the ground up to improve production line work in the mill.

You get accurate slitting at maximum speeds because of the many engineering developments skillfully worked into the design of this Torrington Slitter. For example, adjustment of the upper arbor may be made at both ends simultaneously. You save setup time because the outboard housing slides onto a hinged shelf which swings clear, allowing full access to arbors for changing cutters or arbor sleeves. The 1714 Slitter is arranged for either positive drive of the cutters, or for pull-through operation. Herringbone type gears provide extra power, speed and quietness. Air operated feed rolls and side guides facilitate starting a run, insure smooth operation with clean cutting. Anti-friction bearings are used throughout.

For detailed specifications of the various slitters built by Torrington, ask the nearest Torrington representative, or write directly to us.

The **TORRINGTON**
MANUFACTURING COMPANY
TORRINGTON, CONNECTICUT

DURABLE • DEPENDABLE

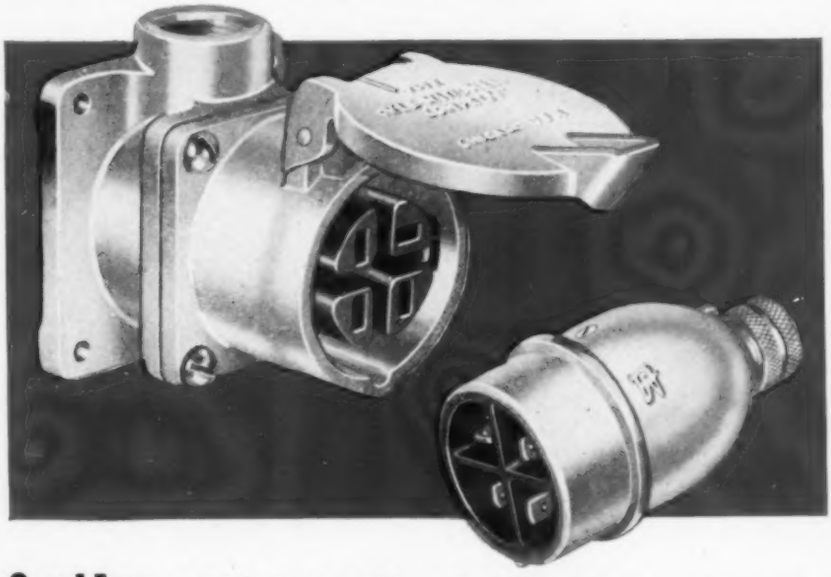
PYLE-NATIONAL

Heavy Duty Plugs and Receptacles

1, 2, 3, 4, 6, 8 pole interchangeable contact units

FOR PORTABLE ELECTRICAL EQUIPMENT

Pyle-National plugs and receptacles are built to withstand the most severe operating conditions, as proven by years of remarkably dependable service in a wide variety of industrial applications. The many substantial construction features of this extensive line of plugs and receptacles and the high quality of materials and workmanship insure safe operation, uninterrupted service and long life.



QuelArc • *Circuit Breaking Series* **Unique partitioned insulation provides long insulated paths through air and across surfaces for exceptional protection in these current rupturing devices. Galvanized cast metal housings, bakelite insulation and individually renewable contacts insure long service life. Ratings 20, 30, 60, 100 and 200 amperes, 250 volts DC, 600 volts AC—2, 3, and 4 pole—grounded through shell or extra pole. Threaded cap, plain and hinged spring door housing styles are available.**

Triploc *and Multiple-Circuit Series*

A line of exceptional versatility, unequalled in the heavy duty field, with a virtually unlimited number of assembly combinations for varied applications. Offers a selection of 1, 2, 3, 4, 6 and 8 pole contact units which are interchangeable and reversible in any single set of housings. Many types of single housings available of pressed steel with automatic lock and of cast metal threaded for watertight gasket seal. Multi-Circuit housings—2, 3 and 4 gang—available for combinations up to 32 poles. Ratings 15 and 20 amperes, 250 volts DC, 460 volts AC—circuit breaking. Pressed steel fusible and fuseless plugs measure 1 13/16" outside diameter.

Midget Triploc *Series* **Same construction features as Triploc except for much smaller outside diameter of plug shell—only 1¼". Interchangeable and reversible contact units—2, 3 and 4 pole—are of the flat blade type. Rated 10 amperes, 250 volts; 15 amperes, 125 volts.**

2-Gang Receptacle

Fusible Plug

Fuseless Plug

General Purpose *Series* **Available with cast metal housings in many types for circuit breaking and disconnect service. 30 amperes, 125 volts DC, 250 volt AC—1, 2, 3, 4, 5 and 6 pole. 60 amperes, 250 and 600 volts—3, 4 and 5 pole. 100 ampere, 250 and 600 volts—2, 3 and 4 pole. Also many special types, fusible and fuseless, for varied applications.**

THE PYLE-NATIONAL COMPANY

1370 NORTH KOSTNER AVENUE, CHICAGO 51, ILLINOIS

Offices: New York • Baltimore • Pittsburgh • St. Louis • St. Paul • San Francisco • Cleveland

Export Department: International Railway Supply Co., New York • Canadian Agent: The Holden Co., Ltd., Montreal

CONDUIT FITTINGS • FLOODLIGHTS • TURBO-GENERATORS • LOCOMOTIVE HEADLIGHTS • MULTI-VENT AIR DISTRIBUTION

MORGANITE POINTERS
on better brush performance —

No. 5-Brush Angle

It is essential that firm contact be maintained between brush face and commutator or collector ring. Aside from characteristics in the brush material itself affecting intimacy of contact, other factors are involved — such as the angle at which the brush rests on the rotating surface.

A trailing angle is one in which the commutator or ring rotates away from the sharp angle at the brush face. A leading or reaction angle is one in which the commutator or ring rotates toward it.

Generally, experience indicates that best contact is achieved by maintaining angles of:

(a) Between 15° and 20° for trailing position.

(b) Between 30° and 40° for leading position.

Considered from any "angle", Morganite products will serve you faithfully.

Morganite INCORPORATED
REGISTERED TRADE MARK
CARBON BRUSHES
LONG ISLAND CITY 1, NEW YORK
453 So. Spring St. Los Angeles 13, Cal. Tel. MUtual 3824
343 So. Dearborn St. Chicago 4, Ill. Tel. WEbster 4936

(*Continued from page 168*)

media cleaning of coal. His most publicized invention was the cyclone thickener for thickening suspensions of very small particles.

John E. Allen has been appointed works superintendent at Central Furnaces and Docks of American Steel and Wire Company, Cleveland, Ohio. Mr. Allen is a native of Shinnston, West Virginia. He is a graduate of West Virginia University, having earned his bachelor of science degree in chemical engineering at that institution. Mr. Allen's experience with the wire company dates back to July 1937, when he started as a laborer at the company's Donora, Pennsylvania, steel and wire works. His progress through the ranks was steady, and in April 1943, he was transferred to the company's Duluth works as general foreman of blast furnaces. Since September 1945, he has been assistant division superintendent, blast furnaces at Duluth.

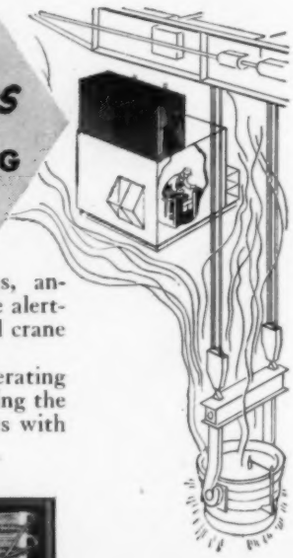
Blair Glenn, general superintendent of the Canton bearing division, Timken Roller Bearing Company, has been promoted to assistant factory manager of the Canton bearing division. Other changes at Timken are:

Henry Tobey, Canton bearing factory metallurgist, was named general superintendent of the Canton bearing factory succeeding Mr. Glenn.

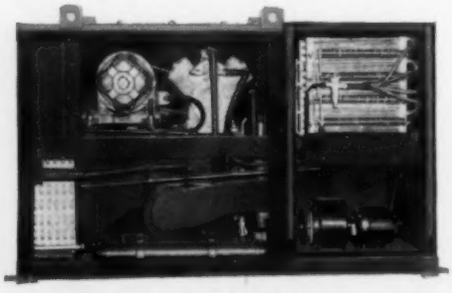
Obituary

Carl Fischer died recently in Pittsburgh after a lingering illness. Mr. Fischer was superintendent of light, heat and power for the Mesta Machine Company, Pittsburgh, Pennsylvania. Born in Germany, he came to the United States in 1915.

DRAVO
CRANE CAB COOLERS
REDUCE OPERATING HAZARDS



● Excessive heat, obnoxious fumes, annoying dust and moisture reduce the alertness and efficiency of your hot-metal crane operators.
● You can eliminate these crane operating hazards by completely air conditioning the cabs on all types of hot-metal cranes with Dravo Crane Cab Coolers.



Completely self-contained Dravo Crane Cab Cooler requires electrical connection only.

DRAVO CORPORATION
PITTSBURGH · PHILADELPHIA · CLEVELAND · NEW YORK
CHICAGO · DETROIT · ATLANTA · BOSTON
Sales Representatives in Principal Cities
DRAVO

DOWELL

SUBSIDIARY OF THE DOW CHEMICAL COMPANY

Do your water lines look like this?

Clean water lines quickly, economically, safely the chemical way!

When efficient operation of water lines is the goal—when a full, free flow of water means something in dollars and cents, Dowell's *chemical* cleaning service merits careful consideration.

The modern, tested Dowell method for quickly and safely removing accumulated scale and sludge has proved effective in water lines everywhere—underground—above ground—indoors or out. Dismantling is unnecessary—even small lines complicated by bends, elbows and valves have been restored to designed capacity. The lines are filled through the regular connections with specially selected liquid solvents designed to dissolve and disintegrate the scale and sludge.

Leading railroads, utilities and other industries rely upon Dowell service engineers to perform the entire cleaning operation—bringing with them adequate equipment—special truck-mounted tanks, pumps, mixers, heaters—to control every stage of the successful job. Ask for free booklet—"More Power to America's Industry!" Illustrated in color, it shows how Dowell specialists chemically clean water lines, steam generating equipment, heat-exchangers and many other types of equipment.

DOWELL INCORPORATED • TULSA 3, OKLAHOMA

New York, Philadelphia, Boston, Baltimore, Pittsburgh, Buffalo, Cleveland, Cincinnati, Detroit, Chicago, St. Louis, Kansas City, Wichita, Oklahoma City, Houston, Fort Worth, Shreveport, Mt. Pleasant, Michigan; Salem, Ill.; Borger, Texas; Wichita Falls, Texas; Midland, Texas; Lafayette, La. Long Beach, Casper: Dowell Associate—International Cementers, Inc.

Dowell's industrial engineers are thoroughly experienced in successful chemical cleaning. They are supported by the full research and technical resources of Dowell's own laboratories.

Dowell's field equipment includes the most modern types of scientific devices. Solvents for Dowell chemical scale removal service are mixed especially to fit each individual job.

FREE SHOWING! *New 18-minute sound slide film illustrating the possibilities of Dowell Chemical Scale Removal Service. To arrange a special showing call or write Dowell.*

Dowell service is supervised by trained engineers using carefully selected liquid solvents and special mobile equipment.

DOWELL

FOR INDUSTRIAL CHEMICAL SERVICE

NOW . . . IT'S HERE!

NEW

BIRDSBORO "50"

The *Super-Alloy Steel Roll* Designed To Give You

HIGH-QUALITY FINISHES

If you want high-quality finishes on the metals you roll, here's a new, super-alloy cast steel Roll whose metallurgy is designed to fit your most exacting requirements. The BIRDSBORO "50" Roll gives you an ideal combination of Copper, Nickel, Chromium, and Molybdenum that adds up to a tight surface grain for smooth, mirror-like finishes.

INCREASED TONNAGES

The new, simplified, BIRDSBORO "50" design keeps maintenance down to a minimum. The right combination of alloys means higher strength, greater resistance to wear—more uninterrupted production.

The BIRDSBORO "50" comes to you with a remarkable ability to resist fire checking. What's more, you can get this advanced design Roll individually made to *your* hardness specifications. For increased tonnages and high-quality production, decide to put the new BIRDSBORO "50" Roll to work, now. Call or drop us a line for full details.

Offices in:
BIRDSBORO, PA. & PITTSBURGH, PA.

Representatives:
332 South Mich. Ave.,
Chicago 4, Ill.

507 Terminal Tower Bldg.
Cleveland 13, Ohio

Birdsboro Steel Foundry & Machine Co. • Birdsboro, Pa.

BIRDSBORO ROLLS

DESIGNERS and BUILDERS OF: Rolls • Crushing Machinery • Steel Mill Equipment • Hydraulic Presses • Special Machinery • Steel Castings

YOU USE 4 + 8

YOU GET 100,000

That's all it takes! Four basic circuits and 8 basic component parts give you more than 100,000 different electronic instrument combinations for processing use.

Flow, level, speed, pressure, temperature, gas analysis, pH, conductivity, etc.—all can be controlled with these interchangeable Bailey units.

With Bailey controls, replacement part stocks are held to a minimum because parts are interchangeable. Maintenance costs are less, too, because maintenance men quickly become familiar with the standardized Bailey units.

Bailey bulletin No. 17 shows how you can use this improved control system. Write for your copy and keep it handy for reference the next time you need process controls:

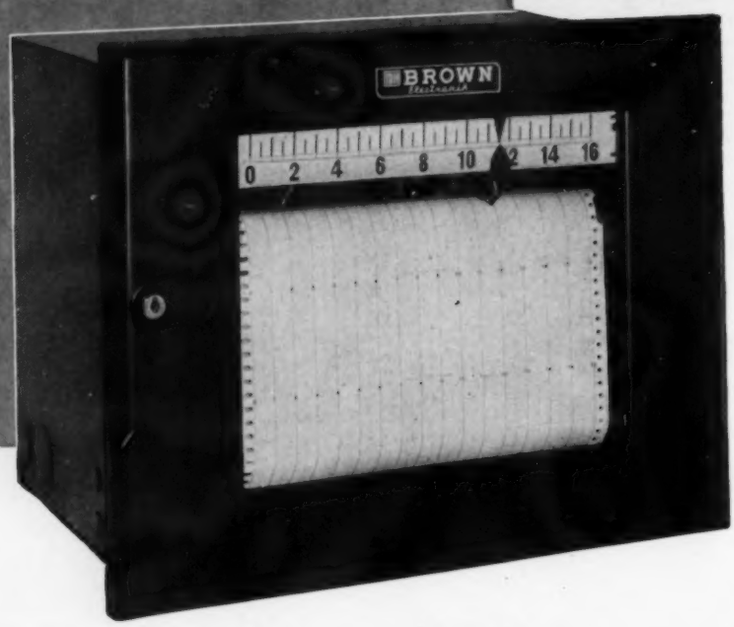
P-19

BAILEY METER CO.
1047 Ivanhoe Rd. • Cleveland 10, Ohio
BAILEY METER CO. LIMITED, MONTREAL
Controls for the Steel Industry
TEMPERATURE • FLOW • PRESSURE
GAS ANALYSIS • LEVEL • RATIO

4 + 8 Works Here at the Irvin Works of the Carnegie-Illinois Steel Corporation.

At last

Control Action comparable to "Continuous Balance" measurement



Both Electric Contact and Proportioning Control

Now Available in Brown *ElectroniK* Potentiometer

A completely new electric control unit is introduced in the Brown ElectroniK Strip Chart Controller. At last, you can capture the full potential of "Continuous Balance" measurement directly in better electric control of your processes.

Available both in *contact* and *proportioning* models, it offers a degree of performance never before possible with electric control.

Contact control models now give "knife edge" sensitivity *plus* all the advantages of mercury switches — forever sealed in glass, permanently protected against dirt, dust, arcing effects and corrosive atmospheres. Absolute, perfect contacts are assured *every time.*

Proportioning control models achieve a new standard of precision for this form of control. Exact control values are produced by an electrically balance-tested resistor circuit.

Surely these electric control models are a fitting complement to the Brown ElectroniK Potentiometer line — for seven years the performance-proven leader in its field.

Additional information will gladly be mailed to you.

Write for Catalog 15-13.

THE BROWN INSTRUMENT CO., 4484 WAYNE AVE., PHILADELPHIA, 44, PA.

DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR CO.

Offices in principal cities of the United States, Canada and throughout the world

BROWN *Advanced Instrumentation* FOR BETTER PROCESSING

Product of MINNEAPOLIS Honeywell

the BILLETEER cuts conditioning costs 4 ways

$ LOWER LABOR COSTS

One semi-skilled operator, using a Billeteer, can do the work of ten hand chippers —radically reducing labor cost and releasing man-power for less-killing, actually-productive work.

$ SUSTAINED EFFICIENCY

Operation of the Billeteer imposes no strains on the worker. Quality and quantity of output never suffer from fatigue, grogginess, jitters, illness or "off" days.

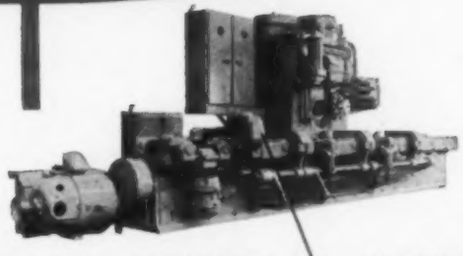
$ VALUABLE SCRAP RECOVERY

The Billeteer does not "burn up" hard-to-get scrap. Every chip can be saved . . . clean . . . classified according to analysis . . . ready for the charging box. In some mills, each Billeteer saves as much as 1½ tons of scrap a day.

$ BILLET SALVAGE

Because of the low operating cost, the Billeteer can be used to salvage billets so badly seamed that it would be impractical to attempt to save them without the Billeteer.

LET US SHOW YOU how much the Billeteer can save in your Billetshed operations.



Engineered

FOR LOWER OPERATING COSTS

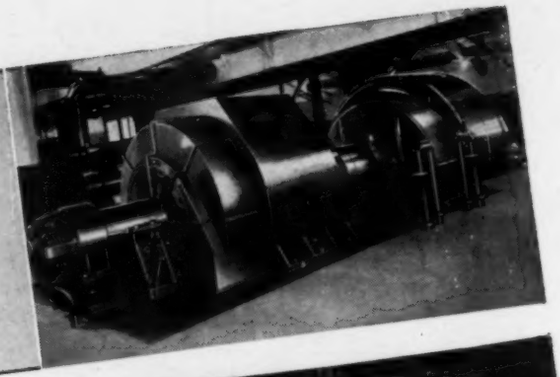
BONNOT

THE BONNOT COMPANY • builders of the BILLETEER • CANTON 2, OHIO

• Bonnot Billet Inspection Tables • Charging Tables • Cold Saws Grinding Pans • Clay Mixers • Clay Feeders, Etc. •

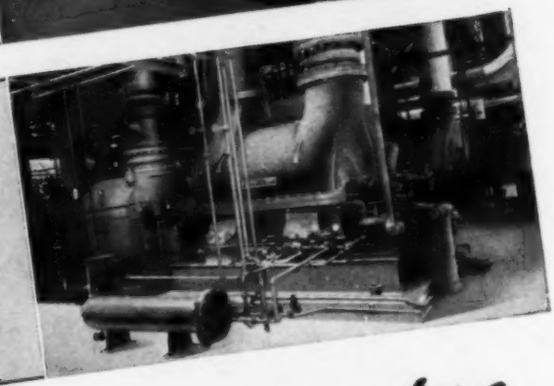
AIR

FOR STEEL PLANTS



FOR COPPER SMELTERS

FOR OIL REFINERIES



That wears a price tag

When air is drawn from the sky and sent racing through a turbo-blower, it is no longer free. Not only does it become an integral part of your manufacturing process, it becomes an important item in your operating costs . . . air that wears a price tag.

That's not all, the price tag can also tell you a lot about the real value of a turbo blower . . . money value that's measured in terms of low Power costs, low Maintenance costs and high Availability. These factors back up the ability of I-R turbo-blowers to consistently lower the cost of air.

LOW POWER COST — Money Saved

LOW MAINTENANCE COST — Money Saved

HIGH AVAILABILITY FACTOR — Money Earned

IT ALL ADDS UP!

Ingersoll-Rand

11 BROADWAY, NEW YORK 4, N. Y.

12-804

COMPRESSORS • AIR TOOLS
CONDENSERS • CENTRIFUGAL PUMPS
OIL AND GAS ENGINES

CLARK CLAMP LIFT TRUCK

WHEN CHOOSING A TRUCK *BE SURE* IT HAS

CLARK CLAMP LIFT TRUCK

DEPENDABLE POWER

EXIDE-IRONCLAD BATTERIES

have lifting power, hauling power, lasting power . . . when you need it, as you need it, and straight through every shift. This extra power of Exide-Ironclad Batteries is due to a unique construction, which differs from that of all other batteries.

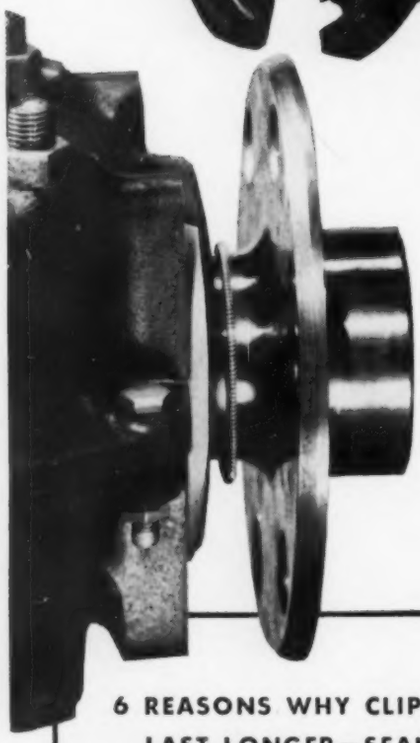
One notable difference is in the positive plate, which consists of a series of slotted tubes containing the active material. So fine are these slots that, while they permit easy access of the electrolyte, they retard the active material from readily washing out.

The results are High Power Ability, High Electrical Efficiency, Ruggedness, Long Life and Low Maintenance. Only Exide-Ironclad Batteries have ALL FOUR of those vital characteristics.

For peak performance and maximum economy, choose the batteries that 81.1%* of electric industrial truck owners prefer—Exide-Ironclad Batteries. **From a recent survey by a leading business publication.*

Write for further particulars and FREE copy of Exide-Ironclad Topics, which covers latest developments in material handling and shows actual case histories.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia 32
Exide Batteries of Canada, Limited, Toronto



HOW TO INSTALL AN OIL SEAL IN 10 SECONDS FLAT

■ It *can* be done—even on an inaccessible shaft like the one pictured here—with a Johns-Manville split-type Clipper Seal. Just three simple steps complete the job:

(1) Hook the detachable garter spring around the shaft. (2) Spread the seal apart at the split as shown above, and slide it over the shaft. (3) Slip the garter spring inside its groove in the seal and press the assembly into the cavity.

That's all. Installation is actually a matter of seconds. Costly "down time" is reduced to a minimum. And you can remove the seal just as quickly and easily . . . and without damage.

Completely new in principle, Clipper Seals have no metal case. Their rigid heel and soft flexible lip are moulded into a single unit to provide a seal of superior lubricant-retaining, dirt-excluding qualities. The garter spring adjusts lip pressure, contributes to more effective sealing and longer life.

Clipper Seals are made in both split and endless types and are available for shafts up to 66″ in diameter. They are recommended for sealing against oil, grease, water, air, grit and coolants at operating temperatures up to 450° F.

For further information, write for brochure PK-31A. Address Johns-Manville, Box 290, New York 16, New York.

6 REASONS WHY CLIPPER SEALS LAST LONGER—SEAL BETTER

1. Various durometer lip stocks are available in a variety of designs to meet many different working conditions.
2. Clipper Seal's rigid heel provides a press fit in the cavity assuring a leak-proof joint at this point.
3. Clipper Seal's non-metallic moulded body is highly resistant to most forms of corrosion.
4. Every Clipper Seal has the same accurate concentricity because the I.D. and O.D. are moulded concentrically.
5. Action of garter spring adjusts lip pressure to provide more effective sealing and longer seal life.
6. Tough, one-piece construction permits easy removal without damage so that the seal can be used again.

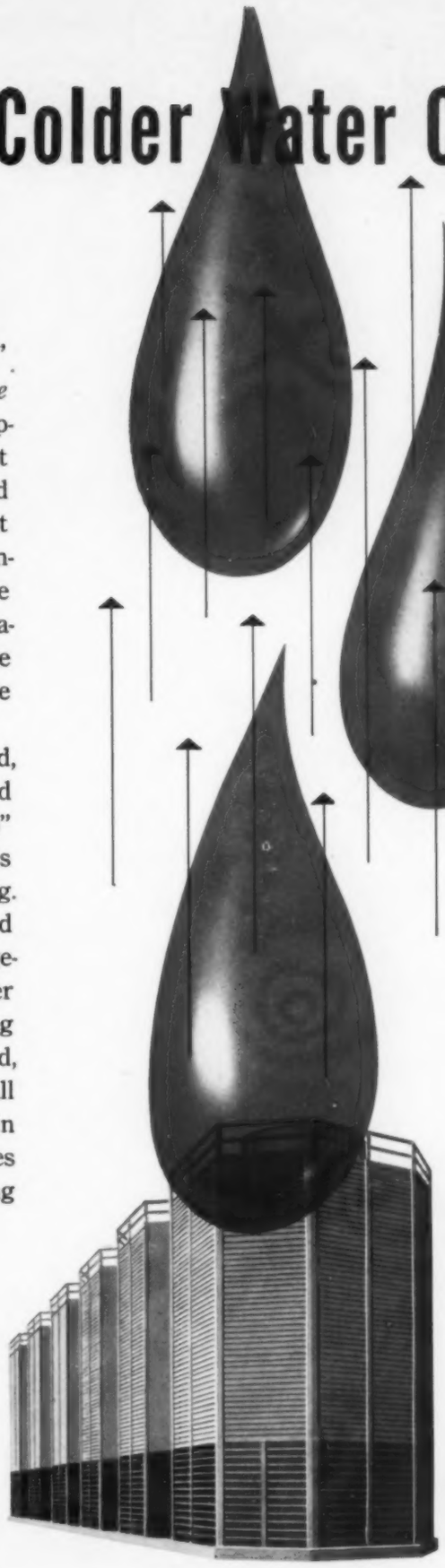
Johns-Manville **PACKINGS & GASKETS**

TRUE COUNTERFLOW = Colder Water Cheaper

Cheaper? Yes, and here's why: Fluor "Counterflo" Cooling Towers incorporate the principle of *true* counterflow: the air current travels directly opposite to the water current. Result? The coldest air contacts the coldest water; the hottest and most humid air (exhaust) contacts the hottest water. All the exhaust air approaches the temperature of the incoming hot water while all the cooling water approaches the wet bulb temperature of the entering air...thus taking advantage of the greatest possible terminal temperature differential so vital to efficient heat transfer.

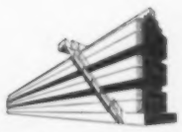
Assuming tower size, tower height, heat load, water circulation, wet bulb temperature and air quantity are equal, the Fluor "Counterflo" Cooling Tower will deliver colder water than is possible with either parallel or crossflow cooling.

The Fluor octagonal tower design; patented up-spray distribution nozzles; proper arrangement of grid decking to assure longer air-water contact; fan and gearing developed to give long service life and eliminate recirculation; rigid, time-resistant construction throughout... all add up to one net result: less operational cost in the long run. Yes, fifty years' experience proves that... year in and year out... Fluor Cooling Towers deliver colder water cheaper!



6 Cell "Counterflo" Cooling Tower

Fluor "Counterflo" induced draft cooling towers, prefabricated in mass production, are available in multiple or single units in any required size or height.



Fluor Areator atmospheric cooling towers are recommended where this type is the most practical.

The Fluor Fin-Fan cooling unit has a wide, economical range of utility throughout industry.

BE SURE WITH FLUOR

FLUOR

PRODUCTS : *Cooling Equipment, Mufflers, Gas Cleaners, Pulsation Dampeners*

SERVICES : *Designers and Constructors of Refinery, Chemical and Natural Gas Processing Units*

THE FLUOR CORPORATION, LTD., *Los Angeles 22* · NEW YORK · PITTSBURGH · KANSAS CITY · HOUSTON · TULSA · BOSTON

Easier . . . Faster . . . Smoother Piping Jobs when CRANE-equipped throughout

For power, heating or process piping . . . whatever you need, Crane is the dependable source. Buying from the world's most complete line means delivery of what you want . . . valves, fittings, pipe, accessories, fabricated piping . . . in brass, iron, steel or alloys.

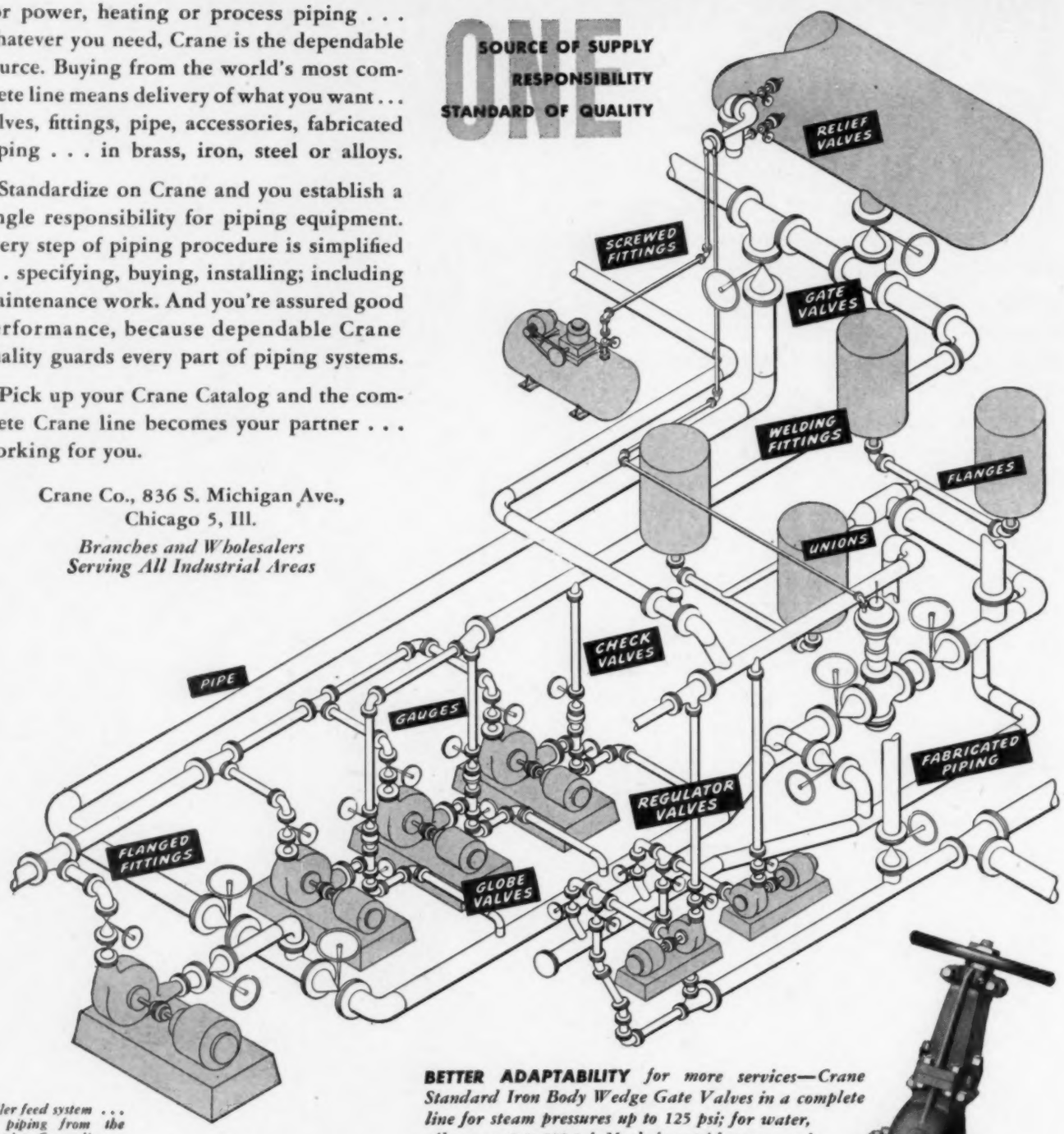
Standardize on Crane and you establish a single responsibility for piping equipment. Every step of piping procedure is simplified . . . specifying, buying, installing; including maintenance work. And you're assured good performance, because dependable Crane quality guards every part of piping systems.

Pick up your Crane Catalog and the complete Crane line becomes your partner . . . working for you.

Crane Co., 836 S. Michigan Ave.,
Chicago 5, Ill.

Branches and Wholesalers
Serving All Industrial Areas

ONE
SOURCE OF SUPPLY
RESPONSIBILITY
STANDARD OF QUALITY



Boiler feed system . . . all piping from the complete Crane line.

BETTER ADAPTABILITY *for more services—Crane Standard Iron Body Wedge Gate Valves in a complete line for steam pressures up to 125 psi; for water, oil or gas up to 200 psi. Made in outside screw and yoke, and non-rising stem patterns; screwed or flanged ends; brass-trimmed or all-iron. In sizes 2 in. and larger. See your Crane Catalog, pp 101-6.*

EVERYTHING FROM . . .

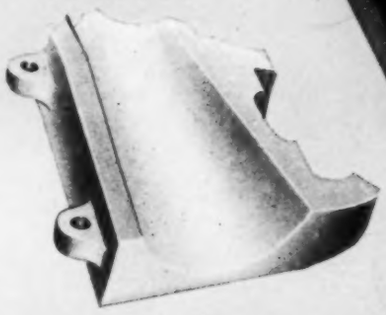
VALVES • FITTINGS
PIPE • PLUMBING
AND HEATING

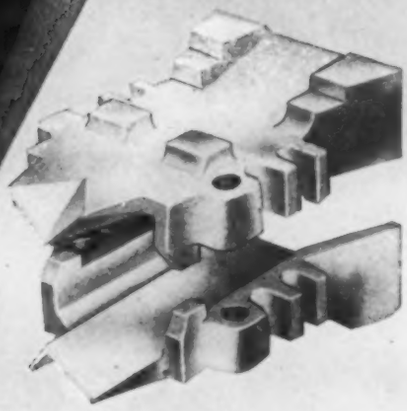
CRANE

FOR EVERY PIPING SYSTEM

TRANTINYL

GUIDES THE STEEL INDUSTRY





PRODUCTION · QUALITY · YIELD

YOUNGSTOWN ALLOY CASTING CORPORATION

YOUNGSTOWN 1, OHIO

Let's clean house now— start scrap moving—

FABRICATORS NEED STEEL

STEEL MILLS NEED SCRAP

Here's what you can do to help get much-needed scrap to Steel Mills.

1 ***Check Your Plant and Property*** and appoint someone to earmark every piece of machinery and equipment that can be cut up for scrap.

2 ***Consult Your Local Scrap Dealer*** to learn what size scrap brings highest returns—then flame-cut to size all obsolete machines, structural shapes, pipe, old boilers, and other large pieces.

3 ***Classify and Segregate*** alloy steels and other special materials to be sure they are used to best advantage and to obtain higher prices.

4 ***Move Scrap Fast*** when it is ready. Sell it, ship it—keep it moving.

Linde can help you work out a practicable scrapping program—just call our nearest office.

•

To help you identify the common metals for proper scrap classification, we will be glad to send you, without charge, as many copies as you need of the wall charts "Identifying Metals by Spark Testing" (ask for form 4666) or "Simple Tests for Identifying Metals" (ask for form 2299).

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

30 E. 42nd St., New York 17, N. Y. UCC Offices in Other Principal Cities

In Canada: Dominion Oxygen Company, Limited, Toronto

FOR LOWER MANUFACTURING COSTS

FROM 200 cfm TO 650,000 cfm

BUFFALO "E" BLOWER

MACHINE TOOLS by "Buffalo"

- BACK SPOT FACERS
- BAR CUTTERS
- BENDING ROLLS
- BILLET SHEARS
- DOUBLE END PUNCHES AND SHEARS
- LOCOMOTIVE SHEARS
- MILL TYPE SHEARS
- RAPID ACTING PUNCHES
- SINGLE END SHEARS
- SPRUE CUTTERS
- STRUCTURAL IRON WORKERS
- UNIVERSAL IRON WORKERS
- DRILLS FOR THE PRODUCTION LINE DRILLS FOR THE TOOL ROOM

THERE'S A "BUFFALO" FAN TO DO THE JOB BEST!

● Present-day industrial fans are specialists. The "Buffalo" Sintering Fan, above, is a highly specialized installation for a special process. "Buffalo" "E" Blowers are among the smallest "Buffalo" Fans. Between the two are all types of ventilating fans, exhausters, blowers and draft fans — in a wide variety of sizes. All are built for long, economical service on *particular* air jobs. That's why, when you need a fan, it will pay you to get "Buffalo" recommendations. Simply write us.

BUFFALO FORGE COMPANY

173 MORTIMER STREET BUFFALO 4, N. Y.

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.

Branch Offices in all Principal Cities

CONTINUOUS SERVICE—FASTER OPERATION—PEAK ACCURACY

HOW TO MAKE A QUICK SWITCH WITH HEAVIER LOADS

This Diesel-electric switching locomotive was built by the Whitcomb Company, Rochelle, Ill. a subsidiary of the Baldwin Locomotive Works. The builder specializes in developing Diesel, electric, Diesel mechanical and Diesel hydraulic locomotives.

Here's a locomotive for steel mills, shipyards, switching and other similar severe services . . .

Special gearing, made of nickel steel, enables it to start and pull far heavier loads than heretofore possible with locomotives of the same power and weight.

Its triple reduction drive gear unit combats tremendous stress and strain when starting long strings of loaded cars . . . translates all available power of the engine into tractive effort.

The essential high wear resistance in gear teeth and exceptional toughness in the underlying core are secured with low carbon 5 percent nickel steel, Type 2515, case-hardened to 60 Rockwell C on the surface. Lower quenching temperatures permitted by the high nickel content in this steel, minimize both scaling and distortion.

Shafts are specified in 3½ percent nickel steel, Type 2345, at a minimum BHN of 235 for toughness and load carrying ability.

In fact, nickel alloy steels are used for all stressed parts and those subject to shock loads. This preference is a result of the builder's long experience with many types of alloy steels.

Nickel steels offer significant advantages. Write us for recommendations.

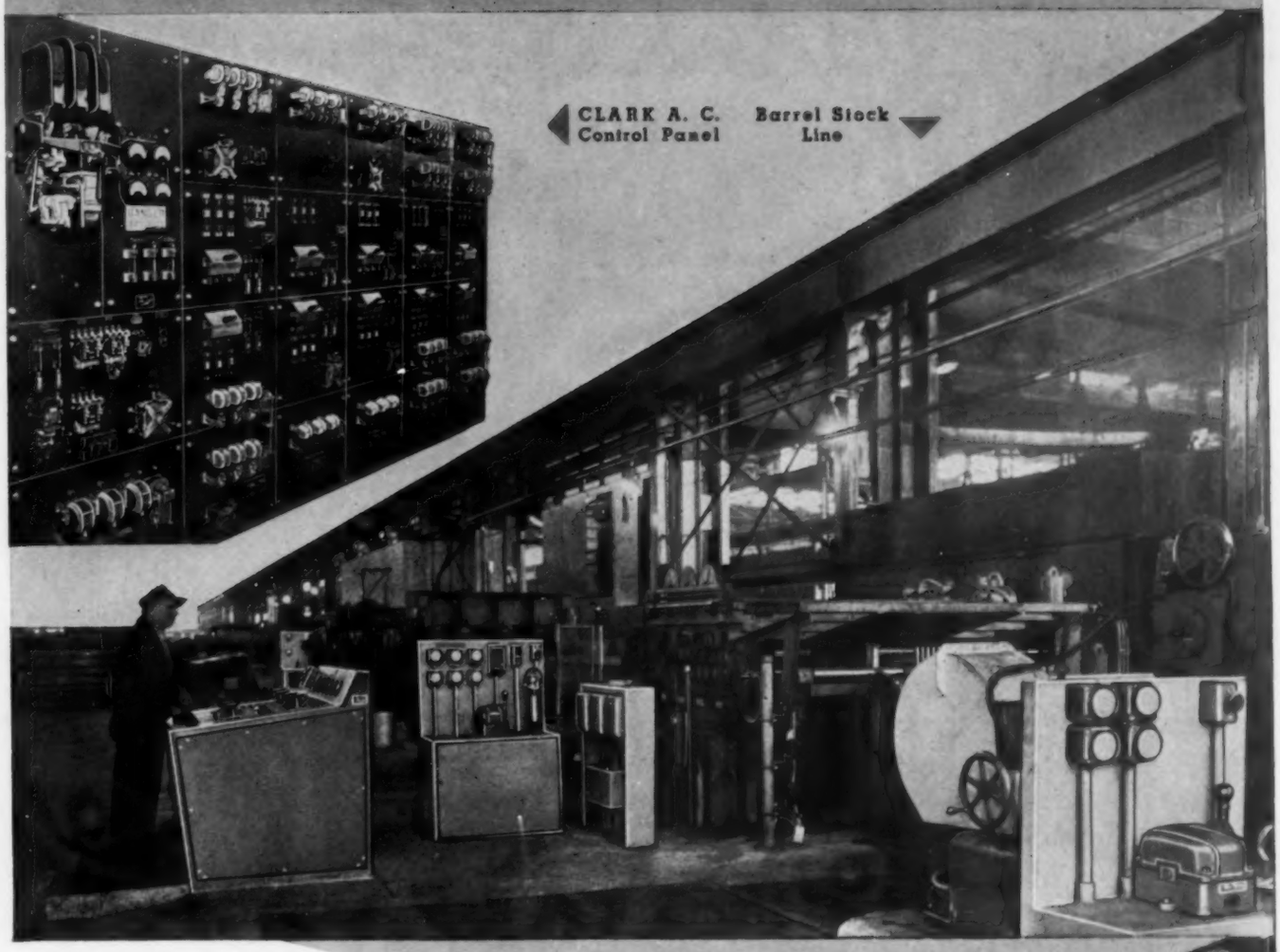
MORE SCRAP—MORE STEEL!... *Move your scrap now!*

EMBLEM OF INCO SERVICE
TRADE MARK

Over the years, International Nickel has accumulated a fund of useful information on the properties, treatment, fabrication and performance of engineering alloy steels, stainless steels, cast irons, brasses, bronzes, nickel silver, cupro-nickel and other alloys containing nickel. This information is yours for the asking. Write for "List A" of available publications.

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

CLARK A. C. AND D. C. CONTROL PANELS FOR BARREL STOCK LINE



● In this Mid-Western Steel Plant, as in countless other Steel Plant control installations all over the world, CLARK HEAVY DUTY STEEL MILL CONTROL proves its worth.

The CLARK control for this Barrel Stock Line features Bulletin 7400 D. C. Vari-Time Contactors which have a trouble-proof, built-in Time Delay—known throughout all heavy industries for their dependable operation. CLARK Bulletin 7700 A. C. Contactors, designed for mill use, also function on these panels.

The Bench Board, at the left of the installation picture, is equipped with CLARK rheostats, Selector Switches and Type D Heavy Duty Push Buttons. At other points in the picture are CLARK Bulletin 100 Type RN (Rough Neck) Push Buttons and Bulletin 101 RD Master Switches.

Designed by Wean Engineering Company using a Hallden Guillotine Flying Shear and a McKay Processing uncoiler and controlled with CLARK engineered apparatus, this Barrel Stock Line is typical of all CLARK ENGINEERED STEEL MILL INSTALLATIONS.

CLARK D. C. Control Panel

EVERYTHING UNDER CONTROL

THE CLARK CONTROLLER CO.

1146 EAST 152nd STREET, CLEVELAND 10, OHIO

Short Circuits Got You Down?

Change to

NON-FLUID OIL

You can practically eliminate electric motor short circuits with drip-less, waste-less Non-Fluid Oil. It does not creep out of bearings, nor is it thrown onto windings by vibration. Insulation is kept clean and burnouts eliminated. Motor frames are kept clean. Besides, NON-FLUID OIL outlasts ordinary lubricants because it lubricates constantly until entirely used up. See for yourself . . . send today for instructive bulletin and free, testing sample of NON-FLUID OIL.

WORKS: Newark, N. J.—WAREHOUSES: Atlanta, Ga. - Greenville, S. C. - Charlotte, N. C. - Providence, R. I. - Chicago, Ill. - St. Louis, Mo. - Detroit, Mich.

NEW YORK AND NEW JERSEY LUBRICANT COMPANY

292 Madison Avenue, New York 17, N. Y.

NON-FLUID OIL is not the name of a general class of lubricants, but is a specific product of our manufacture.

NON-FLUID OIL

TRADE MARK REGISTERED

11 STANDARD SIZES OF PUMP VALVE UNITS TO MEET OVER 300 VARIATIONS IN INSTALLATION REQUIREMENTS.

Durabla Pump Valve Units*, complete for any type of pump installation, under any conditions and in any position, are available in 11 standard sizes to assure economy, accuracy, and avoidance of delay in stocking and installation:—

1. Minimum stock to meet all requirements. Stock units can be supplied rough cast on the outside seat dimension for machining to exact size.
2. Fewer orders necessary.
3. Ease of ordering because of minimum of detailed information needed.
4. Stock can be kept on hand for emergency breakdown requirements.
5. Your own machine shop can be used for fitting and immediate installation of these valves.
6. Durabla Pump Valve Units are complete, ready to be fitted to any pump.

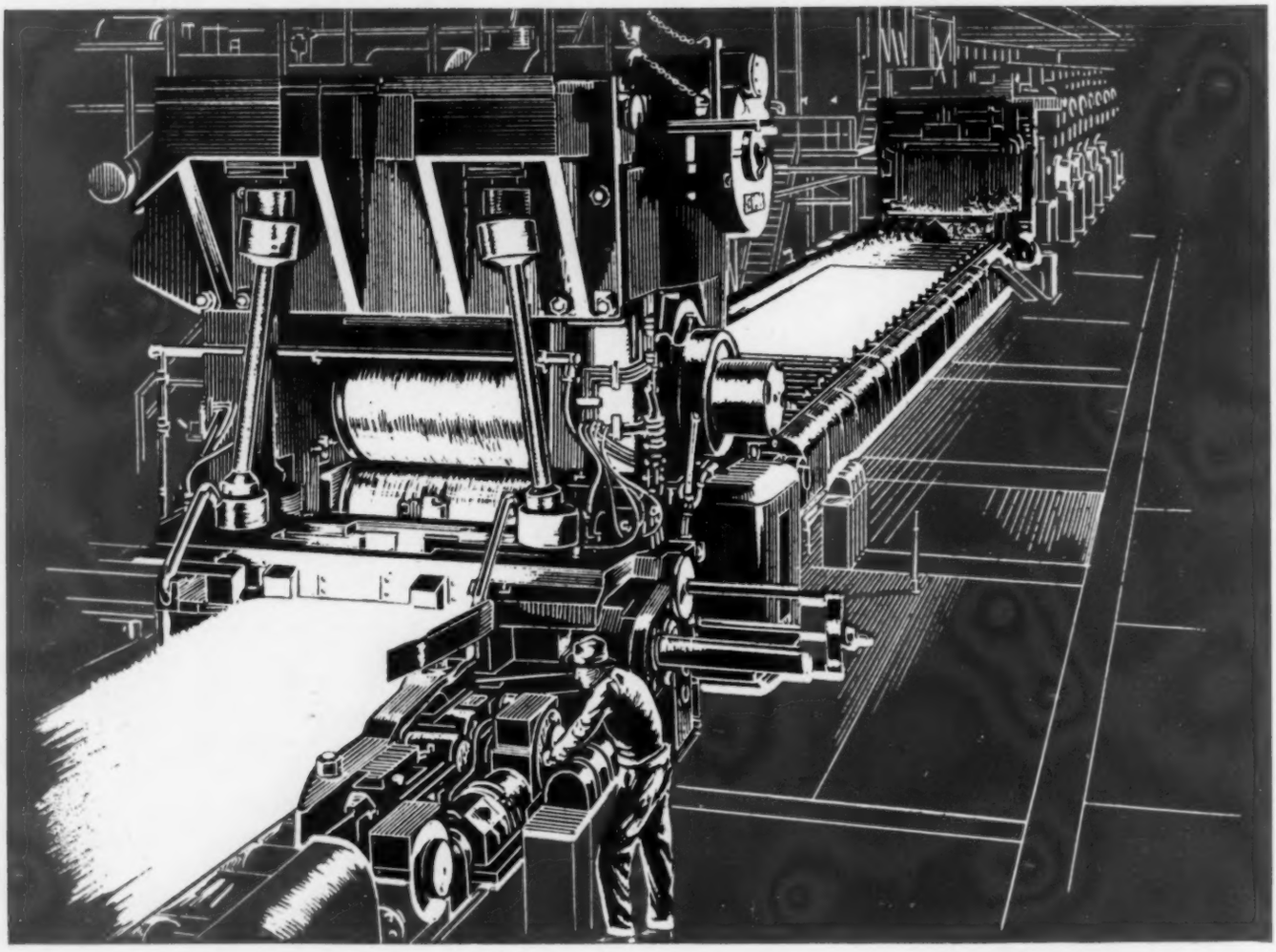
Durabla Standardization has reduced your purchasing and stock problem from over 300 sizes to 11 standard pump valve units. This means time saved in purchasing; simplicity of installation; together with efficiency and long term economy.

Address DURABLA Engineering Department for Information and Bulletin 854

*Patent Numbers 2090486, 2117504

DURABLA MANUFACTURING COMPANY
114 LIBERTY ST. NEW YORK
BRANCHES IN PRINCIPAL CITIES. FOR CANADA REFER: CANADIAN DURABLA LIMITED, TORONTO

YES! Tycol Apreslube Lubricants perform better . . . BETTER . . . BETTER



Tycol Apreslube Lubricants perform better because:

. . . *Tycol Apreslubes* are high quality oils, blended to assure maximum heavy duty lubrication.

. . . *Tycol Apreslubes* resist corrosion, even in the presence of moisture.

. . . *Tycol Apreslubes* will not separate while in storage or service.

. . . *Tycol Apreslubes* are engineered to "take it" without thinning down and dripping out, keep bearings . . . pistons . . . gears friction-free and cool.

For more information on Tycol Apreslubes and the other Tycol industrial "engineered" lubricants, write your nearest Tide Water Associated Office.

TYCOL
INDUSTRIAL LUBRICANTS

Boston • Charlotte, N. C.
Pittsburgh • Philadelphia
Chicago • Detroit • Tulsa
Cleveland • San Francisco

TIDE WATER ASSOCIATED OIL COMPANY
17 BATTERY PLACE · NEW YORK 4, N.Y.

LUBRICATION—"ENGINEERED TO FIT THE JOB"

THE ENGINEERING MART

WHERE TO BUY
EQUIPMENT FOR SALE
POSITIONS VACANT
POSITIONS WANTED

AN *IRON and STEEL ENGINEER* SERVICE TO THE STEEL MILL OPERATORS

WHERE TO BUY

CHICAGO DISTRICT

PAUL W. WENDT & SONS
Manhattan Building
CHICAGO 5, ILLINOIS
District Representatives for
A. W. CADMAN MFG. CO.
HUNTER SAW & MACHINE CO.
GRAFO COLLOIDS CO.

CLEVELAND DISTRICT

HARRY J. FISHER AND ASSOCIATES
635 Ferguson Building
CLEVELAND 14, OHIO
Phone: MAin 0810
Representing:
Clark Controller Company
Lapp Insulator Company, Inc.
Pennsylvania Transformer Company
Branch Offices in Youngstown and Akron

DETROIT DISTRICT

LOYAL R. MILBURN
Consulting Electrical Engineer
Registered State of Michigan
16929 Lawton Avenue
Detroit 21, Michigan
Telephone: University 13874

PITTSBURGH DISTRICT

W. G. KERR CO.
520 Oliver Building PITTSBURGH, PA.
Foote Brothers — Gears and Speed Reducers
Reeves Variable Speed Drives
Thomas Flexible Couplings
Telsmith Crushers
Phone: ATlantic 4254

EDGAR M. MOORE & CO.
502 Renshaw Building
PITTSBURGH 22, PA.
Transformers – Timers – Cable Take-up Reels
Resistors and Rheostats – Selenium Rectifiers
Pumpless Blow Torches

PITTSBURGH (Continued)

PENNELL ASSOCIATES
Complete Material Handling Systems
O. R. Heidenrich
Investment Building
PITTSBURGH 22, PA.
ATlantic 6734
ELWELL-PARKER ELECTRIC CO.
Electric Industrial Trucks
NUTTING TRUCK AND CASTER CO.
Warehouse and Floor Trucks
PHILLIPS MINE AND MILL SUPPLY CO.
Heavy Duty Trailers, Skids, Transfer Cars, Skid Dumps
WHITING CORPORATION
Electric Hoists
LIFT TRUCKS, INC.
Hand and Power Driven Lift Trucks
ELIZABETH IRON WORKS
Bridge Ramps for Car Loading
THE BUDA COMPANY
Buda Chore Boy

PATTERSON-EMERSON-COMSTOCK, INC.
ENGINEERS AND CONSTRUCTORS
Specializing in Steel Mill Construction
313 E. Carson Street
Pittsburgh 19, Pa.
Phone EVerglade 9800

ROLLING MILLS and EQUIPMENT
FRANK B. FOSTER, INC.
2217 OLIVER BUILDING PITTSBURGH 22, PA
Cable Address "FOSTER" Pittsburgh

METALLIC RECUPERATORS
(Air Preheaters)
For application to soaking pits, heating, and other types of metallurgical furnaces.
HAZEN ENGINEERING CO.
Park Building PITTSBURGH, PA.

PITTSBURGH (Continued)

ROBERT T. JOHNSON
District Sales Representative
NORTHERN ENGINEERING WORKS
E.O.T. Cranes – Electric Hoists – Air Hoists
THE HILL-ACME CO.
Alligator Shears – Portable Cranes – Special Machinery
Union Trust Building
PITTSBURGH, PA.
Phone: ATlantic 1535

P R O D U C T S
Acid-Proof Materials

Specify **SAUEREISEN**
ACIDPROOF CEMENTS — COMPOUNDS
FOR
Tanks, Sewers, Stacks, Floors
Technical cements for all purposes.
Send sketches or samples
Sauereisen Cements Company · Pittsburgh 15, Penna.

POSITIONS VACANT

Sales Engineer
Young man with engineering background, hydraulic and air control experience desired. Pittsburgh District. Car necessary. Reply Box 300 IRON AND STEEL ENGINEER, 1010 Empire Building, Pittsburgh 22, Pa.

BUSINESS OPPORTUNITIES

FOR SALE
LARGE GREY IRON FOUNDRY
Modern plant located in a community unusually favorable for this type of operation. Highly mechanized. Unlimited supply of low phosphorus pig iron and coke assured. Available at 25% less than sound value of approx. $1,000,000. Complete details including recent appraisals upon request from exclusive representatives.
BUSINESS BROKERS CO.
100 W. Monroe St., Chicago, Ill.
Randolph 2555

DISPLAYED CLASSIFIED ADVERTISING
$8.00 PER INCH

New Members AISE

Active

WILLIAM E. BAYERS, JR.
Assistant Chief Metallurgist
Great Lakes Steel Corporation
Ecorse, Detroit, Michigan

GRANT R. BROOKES
Electrical Material Controller
Great Lakes Steel Corporation
Ecorse, Detroit, Michigan

M. J. BURGER
Chief Electrical Engineer
Carnegie-Illinois Steel Corporation
Youngstown, Ohio

GEORGE J. CAMPBELL
Assistant Fuel Engineer
Bethlehem Steel Company
Sparrows Point, Baltimore, Maryland

C. WILLIAM CONN
Superintendent — Open Hearth Department
Ford Motor Company
Detroit, Michigan

L. A. FUGASSI
Mechanical and Development Engineer
Weirton Steel Company
Weirton, West Virginia

ERNEST FULLER
Research and Development Engineer
Great Lakes Steel Corporation
Ecorse, Detroit, Michigan

ARTHUR C. GRIMM
Industrial Engineer
Carnegie-Illinois Steel Corporation
Pittsburgh, Pennsylvania

KARL W. GRUBE
Superintendent — Engineering and Maintenance
Superior Steel Corporation
Carnegie, Pennsylvania

GEORGE HERBERT
Assistant Superintendent
Electrical Department
Wheeling Steel Corporation
Steubenville, Ohio

THOMAS W. HERSHELL
Superintendent — Mechanical Maintenance
Wickwire-Spencer Steel Division
Colorado Fuel & Iron Corporation
Buffalo, New York

GEORGE A. HILEMAN
Assistant Chief Design Engineer
Carnegie-Illinois Steel Corporation
Irvin Works
Dravosburg, Pennsylvania

CHARLES HILLER
Electrical Expediter
Great Lakes Steel Corporation
Ecorse, Detroit, Michigan

JOHN H. HOWARD
General Technical Foreman
Hot Rolling Mills
The Carpenter Steel Company
Reading, Pennsylvania

W. JOHN KING
Assistant to Division Superintendent of Rolling
Carnegie-Illinois Steel Corporation
South Works
Chicago, Illinois

JOHN FREDERIC LAND
Assistant to General Manager of Sales
Alan Wood Steel Company
Conshohocken, Pennsylvania

GLENN O. LOUCKS
Time Study Engineer
Great Lakes Steel Corporation
Ecorse, Detroit, Michigan

RICHARD W. MANSBURY
Turn Foreman — Electrical Department
Great Lakes Steel Corporation
River Rouge, Michigan

THOMAS D. MORAN
Plant Engineer
South Chester Tube Company
Chester, Pennsylvania

JAMES O. NELSON
Superintendent Roll Shop
Sheffield Steel Corporation
Sand Springs, Oklahoma

HOWARD S. ORR
Senior Staff Engineering Bureau
Carnegie-Illinois Steel Corporation
Pittsburgh, Pennsylvania

ROBERT L. PITTMAN
Expediter — Purchasing Department
Tennessee Coal, Iron and Railroad Company
Birmingham, Alabama

EDMUND G. PRICE
General Superintendent — National Works
National Tube Company
McKeesport, Pennsylvania

FREDERICK R. PULLEN
Assistant Fuel Engineer
Bethlehem Steel Company
Sparrows Point, Baltimore, Maryland

DONALD A. RICHARDS
General Superintendent
Simonds Saw and Steel Company
Lockport, New York

A. RICHARD SHAY
Assistant to Superintendent
Rod and Wire Mills
Bethlehem Steel Company
Sparrows Point, Baltimore, Maryland

H. DEWEY STITELER
Master Mechanic and Chief Electrician
Schuylkill Division
Alan Wood Steel Company
Conshohocken, Pennsylvania

H. C. TAYLOR
Coke Plant—Blast Furnace Practice
Alan Wood Steel Company
Conshohocken, Pennsylvania

FRED P. TEICHART
Master Mechanic
Companhia de Acero del Pacifico, S. A.
Concepcion, Chile

JOHN L. WOMACK
Crane Design Engineer
Carnegie-Illinois Steel Corporation
Homestead Works
Munhall, Pennsylvania

HARLESTON R. WOOD
Sales Engineer
Alan Wood Steel Company
Conshohocken, Pennsylvania

Associate

JAY O. ACHENBACH
Sales Engineer
Kellogg Appliances Company
Philadelphia, Pennsylvania

GEORGE T. ANDREWS
Assistant Manager — Sales and Engineering
Lewis Foundry and Machine Division
Blaw-Knox Company
Pittsburgh, Pennsylvania

ROBERT R. BALDRIGE
Engineering Clerk — Electrical
United Engineering and Foundry Company
Pittsburgh, Pennsylvania

LEONARD R. CHURCHILL
Chemist — Technical Service Laboratory
Tide Water Associated Oil Company
Bayonne, New Jersey

S. D. CRAINE
Steel Mill Engineer
Socony-Vacuum Oil Company
Chicago, Illinois

JOHN H. DANIELS
Draftsman
A. J. Boynton and Company (Engineers)
Chicago, Illinois (Mingo Junction, Ohio)

GEORGE R. EWAN
Metallurgical Department — Roll Sales
Dominion Engineering Works, Ltd.
Montreal, Quebec, Canada

C. S. FINDLAY
Engineer — Strip Mill Erection
International Construction Company, Ltd.
Port Talbot, South Wales, Great Britain

GEORGE E. JOBBINS
Roll Designer
Boiardi Steel Corporation
Milton, Pennsylvania

NAT JOHNSTON
Salesman
Joseph T. Ryerson & Sons, Inc.
Chicago, Illinois

BERT J. LAMPORT
Lubrication Engineer
United Engineering and Foundry Company
Pittsburgh, Pennsylvania

J. B. LAND
Sales Engineer
General Electric Company
Pittsburgh, Pennsylvania

ALBERT J. LEIBHART
Partner
Draftsmen Associates
Pittsburgh, Pennsylvania

WILLIAM C. MADSEN
Branch Manager — Gary Indiana
Reliance Electric and Engineering Company
Cleveland, Ohio

GEORGE P. MILLINGTON, JR.
District Representative
Gould Storage Battery Corporation
Philadelphia, Pennsylvania

DON D. MONTIE
Sales Engineer
General Electric Company
Detroit, Michigan

WILLIAM HENRY MORGAN
President
The Morgan Engineering Company
Alliance, Ohio

WALTER A. RANKIN
Owner
Walter A. Rankin Company
Drexel Hill, Pennsylvania

H. A. REYNOLDS
Superintendent
A. J. Boynton and Company
Chicago, Illinois

BERNARD PAUL SARASIN
Chemical Engineer
A. J. Boynton and Company
Chicago, Illinois

LEO A. TACHOIR
Lubrication Engineer
Tide Water Associated Oil Company
Pittsburgh, Pennsylvania

WILLIAM G. THOMPSON
Electrical Draftsman
United Engineering & Foundry Company
Pittsburgh, Pennsylvania

RUDOLPH TIETIG, JR.
Engineer
A. J. Boynton and Company
Chicago, Illinois

C. P. WOOD
Field Engineer
Thomas A. Edison, Inc.
Edison Storage Battery Division
Chicago, Illinois

D. MICHAEL WUCHENICH
Partner
Draftsmen Associates
Pittsburgh, Pennsylvania

MILTON E. YOUNG
Sales Engineer
Electric Controller & Manufacturing Company
Chicago, Illinois

ALFONS ZULLIG,
Chief Engineer
Aluminiumwerke A. G.
Rorschach, Switzerland

Junior

M. H. MERICLE
Electrical Department Trainee
Republic Steel Corporation
Chicago, Illinois

INDEX TO ADVERTISERS

A

Aetna Standard Engineering Company 1
Air Reduction Sales Company 144
Alliance Machine Company 132, 133
Aluminum Company of America 155
American Air Filter Company, Inc. 4
American Chemical Paint Company 130
Amsler-Morton Corporation 162

B

Babcock & Wilcox Company, The 137
Badall Engineering and Manufacturing Company 28
Bailey Meter Company 175
Bantam Bearings Division of
The Torrington Company 140
Bedford Foundry and Machine Company 164
Birdsboro Steel Foundry and Machine Company 174
Blaw-Knox Division, Blaw-Knox Company 129
Bliss Company, E. W. 6, 7
Bloom Engineering Company 136
Bonnot Company 177
Brown Instrument Company 176
Buffalo Forge Company 185
Bussmann Manufacturing Company 116, 117

C

Clark Controller Company 187
Cleveland Crane and Engineering Company 34
Cleveland Worm and Gear Company, The ... Cover 3
Continental Foundry and
Machine Company 121, 157
Crane Company 182
Crouse-Hinds Company 119
Cunningham Company, M. E. 138
Cutler-Hammer, Inc. ..... Cover 2

D

De Laval Steam Turbine Company 166
Documentation & Licenses, Paris, France 38
Dowell, Inc. 173
Dravo Corporation 172
Drever Company, The 38
Durabla Manufacturing Company 189

E

Electric Controller and
Manufacturing Company 3, 194
Electric Storage Battery Company 179

F

Falcon Bronze Company 136
Farrel-Birmingham Company, Inc. 169
Flinn & Dreffein Engineering Company 38
Fluor Corporation, Ltd., The 181

G

Gas Machinery Company, The 131
General Electric Company ..... Cover 4
Gleason and Company, Inc., J. L. 126

H

Hallden Machine Company, The 38
Hauck Manufacturing Company 164
Hays Corporation, The 128
Hunt and Son, Inc., C. B. 141

I

Ingersoll-Rand Company 178
International Nickel Company 186
I-T-E- Circuit Breaker Company 153

J

Johns-Mansville Corporation 180
Jones Foundry and Machine Company, W. A. ... 135

K

Kling Brothers Engineering Works 156

L

Leeds and Northrup Company 118
Lewis Foundry and Machine Division,
Blaw-Knox Company 27
Lincoln Engineering Company 37
Linde Air Products Company 184
Link-Belt Company 12
Lintern Corporation 158
Loftus Engineering Corporation 161
Lumnite Division,
Universal Atlas Cement Company 120

M

Mackintosh-Hemphill Company 139
McKay Machine Company 38
McKee and Company, Arthur G. 30, 31
Mesta Machine ..... Cover 1
Metalock Repair Service, Inc. 168
John Miles and Partner (London, Ltd.) 38
Morgan Construction Company 36, 127
Morgan Engineering Company 122
Morganite, Inc. 172

N

National Carbon Company, Inc. 150
National Erie Corporation 33
National Roll and Foundry Company 2
New York and New Jersey Lubricant Company .. 188
North American Manufacturing Company 145

O

Ohio Electric Manufacturing Company 125
Okonite Company, The 163

P

Pannier Brothers Stamp Company 143
Peerless Pump Division,
Food Machinery Corporation 142
Pennsylvania Transformer Company 146
Pittsburgh Lectromelt Furnace Corporation 40
Pittsburgh Rolls Division,
Blaw-Knox Company 29
Pollock Company, Wm. B. 159
Poole Foundry and Machine Company 18
Post-Glover Electric Company 16
Pyle-National Company 171

R

Reliance Electric and Engineering Company 32
Rockbestos Products Corporation 26

S

Salem Engineering Company 25
Smeeth-Harwood Company 138
Square D Company 5
Surface Combustion Corporation 21, 22, 23, 24
Swindell-Dressler Corporation 149

T

Texas Company, The 9
Tide Water Associated Oil Company 190
Timken Roller Bearing Company 10, 11
Titanium Alloy Manufacturing Company 160
Torrington Manufacturing Company, The 170

U

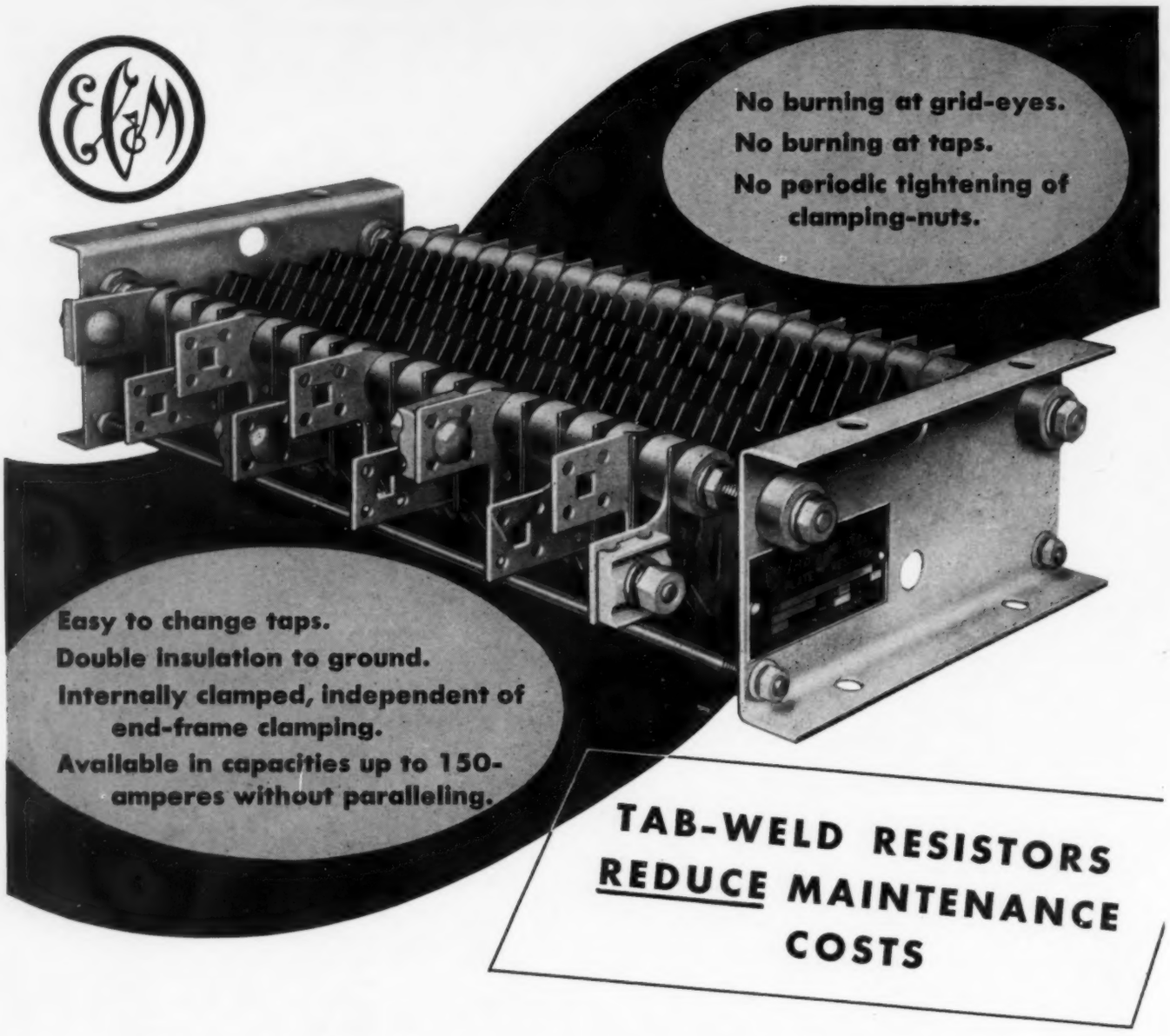
Union Carbide and Carbon Corporation 150, 184
Union Steel Castings Division,
Blaw-Knox Company 165
United Engineering and Foundry Company 17

W

Wagner Electric Corporation 8
Ware Brothers 154
Wean Engineering Company, Inc., The 38
Wean Engineering Company of Canada,
Limited, The 38
Wean Equipment Corporation 38
Westinghouse Electric Corporation 14, 15
Whitcomb Locomotive Company, The 13
Wilson Engineering Company, Inc., Lee 167
Wing Manufacturing Company, L. J. 169

Y

Youngstown Alloy Casting Corporation 183
Youngstown Welding and Engineering Company . 134


No burning at grid-eyes.
No burning at taps.
No periodic tightening of clamping-nuts.
Easy to change taps.
Double insulation to ground.
Internally clamped, independent of end-frame clamping.
Available in capacities up to 150-amperes without paralleling.

TAB-WELD RESISTORS REDUCE MAINTENANCE COSTS

Resistors used in electrical control service are usually mounted in out-of-the-way places. Because they are difficult to get at, periodic inspection is often neglected until trouble develops. Then, the mere tightening-up of bolts is frequently too late. Sections must be completely gone over, even torn down to repair the damage in concealed areas. *EC&M TAB-WELD Resistors eliminate this expense.* Tap-plates are welded in place, affording a *rigid terminal* for connecting external wires. These plates, located at frequent intervals, make it easy to shift taps. The spot-welding of mated ends of adjacent resistors keeps the resistance value constant. Reduce maintenance costs with TAB-WELD Resistors.

TRADE MARK
TAB WELD
PLATE RESISTOR
PATENT NO. 2,378,058

SPECIFY EC&M Bulletin 942
TAB-WELD Resistors.

THE ELECTRIC CONTROLLER & MFG. CO.

2698 East 79th Street • Cleveland 4, Ohio

As the white outline indicates, a standard unit of much greater frame size would be required to do the work of Speedaire.

Clearance to spare with SPEEDAIRE

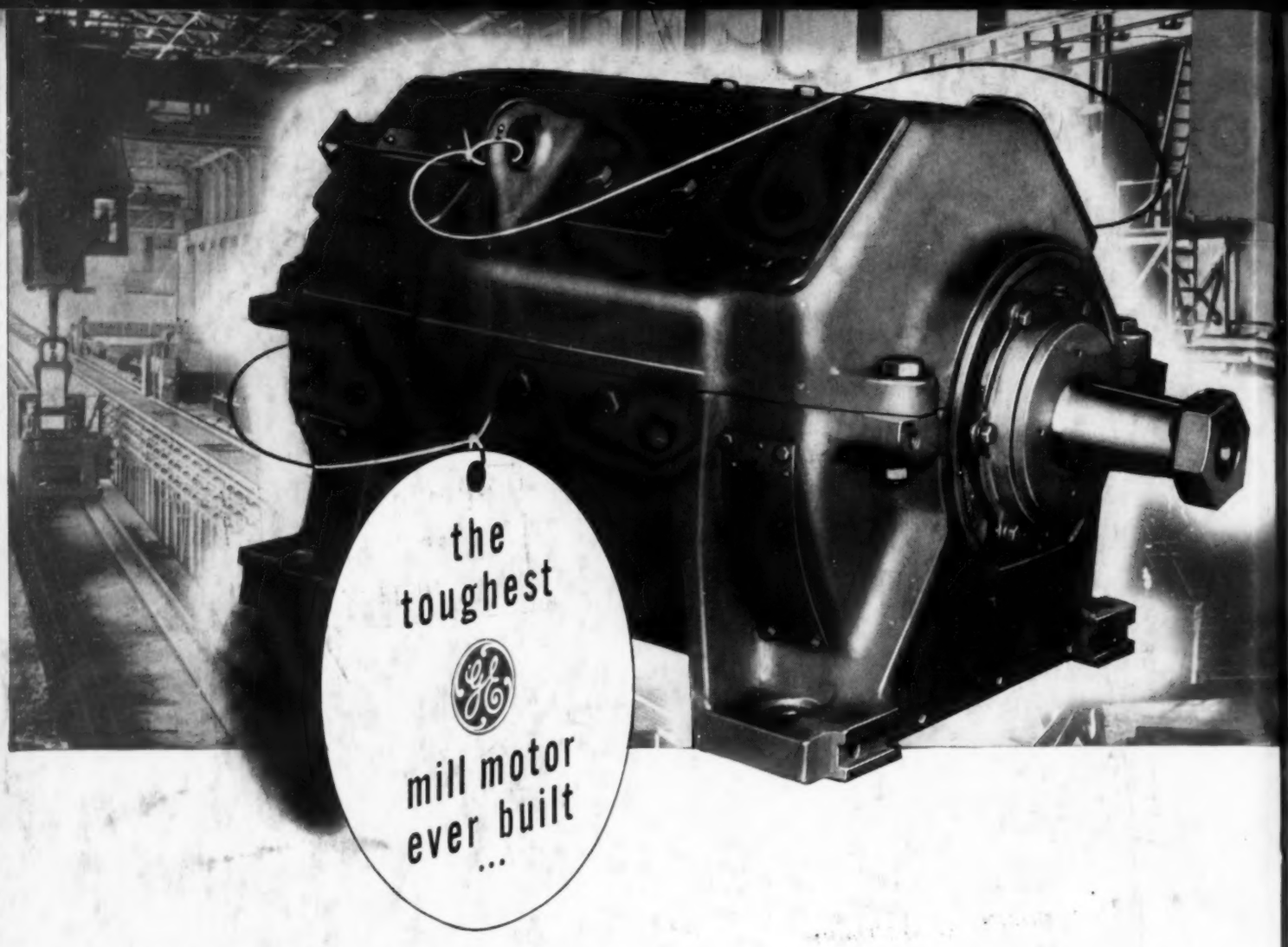
SPEEDAIRE is the only practicable worm gear drive for this portable coal conveyor. A standard unit of comparable capacity would not clear the 36″ ceiling as it is 7½″ taller. It could not be used in many other parts of the mine. The conventional drive also weighs a third more than Speedaire and would require a heavier mounting, making it more difficult to move the conveyor. Dollar-wise, Speedaire saved $130.

Speedaire is Cleveland's new fan-cooled worm-gear speed reducer. Because it is fan-cooled, Speedaire will do more work—will deliver up to *double the horsepower* of standard worm units of equal frame size, at usual motor speeds. It can be installed economically on many applications where other types have been used heretofore—giving you the advantage of a compact right-angle drive. Speedaire gives the same long, trouble-free service characteristic of all Clevelands.

For full description, send for Catalog 300. The Cleveland Worm & Gear Co., 3278 East 80th St., Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

CLEVELAND
Worm Gear
Speed Reducers



...gives you more hp per frame size!

Now you can get a General Electric d-c mill motor—the MD-600—with more horsepower in the same AISE frame size. For example, a 25-hp motor is now available in the No. 6 frame where formerly a No. 8 frame was required. AISE mounting dimensions and safety factors remain unchanged—you simply get a lighter, smaller motor with all the efficiency and power of the next highest frame size.

Several important features of the MD-600 motor make this space and weight saving possible. Better use of available space, particularly in mounting the bearings, is one. Improved glass insulation permits larger current-carrying conductors. The MD-600 has a more efficient ventilating system. Finally, a full set of commutating poles on the entire line of motors has extended the sparkless-commutation zone. For complete technical information on how the MD-600 motor can help you cut costs in your mill, write for Bulletin GEA-4654. *Apparatus Dept., General Electric Company, Schenectady 5, N. Y.*

THE MD-600 . . . FIRST IN ITS FIELD
for these 8 reasons!

- **Cast-steel frame with heavier cross-section**
- **Solid cylindrical-roller-type bearings**
- **Universal frame for all types of enclosures**
- **Better commutation at all loads and speeds**
- **Lighter weight, shorter length**
- **Higher maximum safe speeds**
- **Better armature insulatio**
- **Low Wk², improved efficiency, less heating**

MD-600 MILL MOTORS

GENERAL ELECTRIC

29-47